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Energy Research Abstracts

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Technical Information Center
UNITED STATES DEPARTMENT OF ENERGY

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ERROR NOTICE

An error during the compilation of ERA Vol. 5, No. 8, April 30, 1980, resulted in the Table of Contents for Issue No. 7 being republished. The correct Table of Contents for Issue No. 8, distributed with this issue, should replace the pages originally published.

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ENERGY RESEARCH ABSTRACTS

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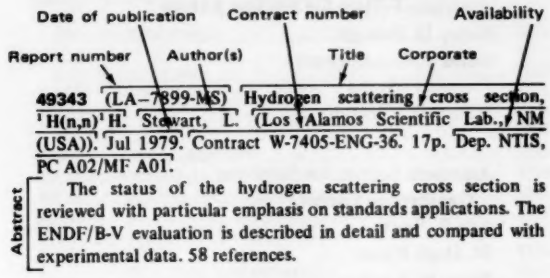
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Title
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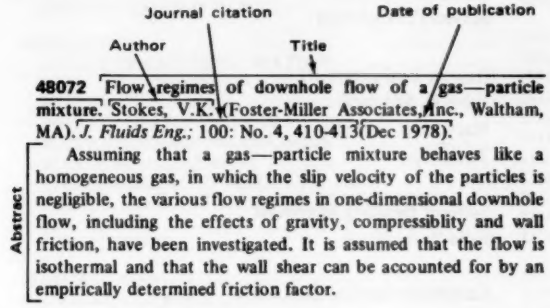
49343 (LA–7899-MS) Hydrogen scattering cross section, ¹H(n,n)¹H. Stewart, L. (Los Alamos Scientific Lab., NM (USA)). Jul 1979. Contract W-7405-ENG-36. 17p. Dep. NTIS, PC A02/MF A01.
Abstract
The status of the hydrogen scattering cross section is reviewed with particular emphasis on standards applications. The ENDF/B-V evaluation is described in detail and compared with experimental data. 58 references.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Date of publication
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Title
48072 Flow regimes of downhole flow of a gas—particle mixture. Stokes, V.K. (Foster-Miller Associates, Inc., Waltham, MA). J. Fluids Eng.; 100: No. 4, 410-413 (Dec 1978).
Abstract
Assuming that a gas—particle mixture behaves like a homogeneous gas, in which the slip velocity of the particles is negligible, the various flow regimes in one-dimensional downhole flow, including the effects of gravity, compressiblity and wall friction, have been investigated. It is assumed that the flow is isothermal and that the wall shear can be accounted for by an empirically determined friction factor.

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Los Alamos Scientific Lab., NM (USA)
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Stewart, L., Hydrogen scattering cross section, ¹H(n,n)¹H, 4:49343 (LA–7899-MS)
Stewart, M.D., *See* McInroy, J.F., 4:49280
Stewart, W., *See* Dean, J.W., 4:48543
Stimson, J., Reproduction, growth, and survival of Enewetak corals, 4:49200 (NVO–0703-1, pp 56-59)

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HYDROGEN 1 TARGET/NEUTRON REACTIONS
Hydrogen scattering cross section, ¹H(n,n)¹H (Above 100 keV, review), 4:49343 (LA–7899-MS)
HYDROGEN NITRATES
See NITRIC ACID
HYDROLOGY/RESEARCH PROGRAMS
Inventory of advanced energy technologies and energy conservation research and development: 1976-1978. Volume II. Prepared for the Committee on Science and Technology, U.S. House of Representatives, Ninety-Sixth Congress, 4:48749

•Contract Number Index

DOE technical report literature is indexed using contract numbers. This index contains the contract number with corresponding abstract and report numbers.

W-7405-ENG-36	Los Alamos Scientific Lab., NM (USA)	
	3:49698	LA-tr–78-45
	3:49857	LA–7224T
	3:49863	LA–7235-MS
W-7405-ENG-48	California Univ., Livermore (USA). Lawrence Livermore Lab.	
	3:49386	UCRL–52456
	3:49431	UCRL–52405

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Volume 5, Number 19, October 15, 1980

ENERGY RESEARCH ABSTRACTS

COAL AND COAL PRODUCTS

REFER ALSO TO CITATION(S) 30119

30050 (DOE/RA/20005—1) **Inventory of federally-funded projects and programs related to anthracite.** (Berger Associates, Harrisburg, PA (USA)). Jun 1980. Contract AC01-79RA-20005. 101p. NTIS, PC A06/MF A01.

This report is a compilation of descriptions of federal projects and programs that are concerned in some way with anthracite. It is the first inventory of its type to be prepared. Among the projects and programs described are those completed in the latter half of 1979, those that are currently active, and others that will start soon. Of the 43 projects described, 8 involve research, development, and demonstration (RD and D) of technologies aimed at enhancing the use of anthracite or anthracite mining waste; 6 address environmental problems associated with anthracite mining or use; 9 provide information on the anthracite industry; 16 involve studies related to anthracite; and 4 are miscellaneous projects and programs. These projects and programs represent federal government expenditures of $27.1 million, excluding current military purchases of anthracite for use in European bases of $33.6 million, and US Bureau of Mines mined land demonstration and reclamation projects of $38.3 million.

PROCESSING

DESULFURIZATION AND PURIFICATION

REFER ALSO TO CITATION(S) 30079, 30084, 30089, 30100, 30102, 30407

30051 (DOE/PC/30141—T1) **Laboratory study for removal of organic sulfur from coal. Quarterly technical progress report.** (TRW, Inc., Redondo Beach, CA (USA)). Jul 1980. Contract AC22-80PC30141. 26p. NTIS, PC A03/MF A01.

Substantial progress has been made in the development of the Gravimelt Process for removal of organic sulfur from coal. Three reactors have been fabricated for both material balance studies of the desulfurization of coal with caustic and examination of the behavior of model organic and inorganic sulfur-containing compounds with the same mixture. Model organic sulfur conpounds have been procured and samples of Kentucky No. 9 coal enriched in mineral matter and samples enriched in organic matter have been prepared by float sink techniques for use in determining mechanism and products of the desulfurization reactions. Initial experimentation has been aimed at determining the fate of sulfur removed from coal and obtaining semi-quantitative information for future material balance studies. These studies show near 90% of the sulfur content of the Kentucky No. 9 coal was removed and approximately 3/4 of this removed sulfur was found by chemical analysis to be in the caustic phase. It was further determined that approximately 1% of the coal organic matter dissolves into the caustic phase. These results indicate rough material flows and show that material balance measurements are feasible. A preliminary conceptual engineering design for a full scale Gravimelt coal desulfurization plant was prepared in order to guide future laboratory efforts toward obtaining key engineering data. The engineering study indicates that the Gravimelt Process can be designed utilizing state of the art equipment and that likely energy recovery is approximately 90%. It is estimated that coal desulfurization costs will be in the range of $20 per ton of coal produced, or $.70/$10^6$ Btu, in 1980 dollars.

30052 (DOE/PETC/TR—80/6) **Air/water oxydesulfurization of coal: laboratory investigation.** Warzinski, R.P.; Friedman, S.; Ruether, J.A.; LaCount, R.B. (Department of Energy, Pittsburgh, PA (USA). Pittsburgh Energy Technology Center). Aug 1980. 117p. NTIS, PC A06/MF A01.

Air/water oxidative desulfurization has been demonstrated in autoclave experiments at the Pittsburgh Energy Technology Center for various coals representative of the major US coal basins. This experimentation has shown that the reaction proceeds effectively for pulverized coals at temperatures of 150 to 200°C with air at a total system pressure of 500 to 1500 psig. Above 200°C, the loss of coal and product heating value increases due to oxidative consumption of carbon and hydrogen. The pyritic sulfur solubilization reactions are typically complete (95 percent removal) within 15 to 40 minutes at temperature; however, significant apparent organic sulfur removal requires residence times of up to 60 minutes at the higher temperatures. The principal products of the reaction are sulfuric acid, which can be neutralized with limestone, and iron oxide. Under certain conditions, especially for high pyritic sulfur coals, the precipitation of sulfur-containing compounds from the products of the pyrite reaction may cause anomalous variations in the sulfur form data. The influence of various parameters on the efficiency of sulfur removal from coal by air/water oxydesulfurization has been studied.

30053 (FE—2739-T1) **Desulfurization with transition metal catalysts. Final technical report, August 1, 1977-July 31, 1979.** Eisch, J.J. (State Univ. of New York, Binghamton (USA). Dept. of Chemistry). 1979. Contract EF-77-G-01-2739. 20p. NTIS, PC A02/MF A01.

Since existing desulfurization procedures generally require elevated temperatures, high pressures of hydrogen and the use of heterogeneous catalysts, such methods are unsuitable for the mild, controlled, stepwise degradation of coal required for coal structural studies. At the same time, such processes are not the most efficient or economical for the practical purification of coal-derived fuels and chemicals. By replacing certain heterogeneous transition-metal catalysts by homogeneous or polymer-bonded catalysts, many important reactions, such as hydrogenation, unsaturated-hydrocarbon oligomerization and hydroformylation, show significant gains in rate or selectivity. Therefore, it is appealing to consider whether the catalytic scission of carbon-sulfur bonds might be achievable at much lower temperatures and pressures by the use of soluble transition-metal catalysts. Such mild desulfurizing conditions might mean a saving of time, energy and equipment expense for industrial processes used in desulfurizing coal-derived fuels and chemicals. In addition, homogeneous agents capable of cleaving carbon-sulfur bonds at low temperatures could be valuable in selectively degrading the macrostructure of various coals themselves into fragments suitable for structural studies. Ongoing research has uncovered novel nickel (0) reagents that desulfurize dibenzothiophene in an homogeneous medium at temperatures below 100°. The first objective of this research, therefore, has been to make a thorough study of the mechanism and scope of this desulfurization, in which study a variety of organic sulfur compounds are being examined and the experimental variables maximized for mild, complete reaction. The second objective has been to evaluate low- or zero-valent transition metal compounds of molybdenum, tungsten, cobalt and iron, and to test their desulfurizing efficacy on a series of model organosulfur derivatives.

30054 (LBL—10319, pp 4.32-4.33) **Coal desulfurization.** Ergun, S.; Lynn, S.; Petersen, E.E.; Vermeulen, T.; Wrathall, J.A.; Clary, L.; Cremer, G.; Mesher, J.; Mixon, D.A.; Smith, M.C. Feb 1980. In Chemical process research and development program, FY 1979.

LBL is involved in five aspects of research on pretreatment of coal prior to combustion to decrease sulfur emissions. The first aspect is development of an acidic oxidative leach process involving H_2SO_4, (a cheap and readily available bulk chemical) in combustion with $Fe_2(SO)_3$ and O_2 or possibly H_2O_2. Pyrite oxidation is complete under mild conditions (160°C, 30 atm oxygen pressure). The second aspect involves development of techniques for independent analysis

of sulfur forms other than pyrite or sulfate. The first has been directed toward spectrophotometric identification of elemental sulfur, which may be an unwanted byproduct of pyrite oxidation, and also a component of raw coals. Another study has deaalt with direct identification of organic sulfur, using x-ray fluorescence. Hitherto, this component has been determined as a difference between inorganic sulfur (pyrite, sulfate, elemental) and total sulfur. The third aspect considers the question of whether the organic sulfur species in coal can be effectively converted to water-soluble products without serious loss in the coal's calorific value. The fourth aspect is reductive desulfurization of primary conversion products from raw coal, for example high-sulfur forms of solvent-refined coal. The catalytic action of pyrite in hydrodesulfurization and the physical and chemical factors affecting that catalyses have been an area of study. The fifth aspect is combustion of coal that has been treated with a trapping agent, notably an alkali metal base or salt. Chemical costs for such treatment will probably be comparable to those for alkaline or neutral desulfurization, or lower if the cost of oxidizing agent (O_2, air, H_2O_2) is included.

30055 (ORNL/TM—6377/V2, pp 2-108) **Chemical engineering research.** Jul 1980.

In Advanced technology section semiannual progress report, October 1, 1977-March 31, 1978. Volume 2. Engineering Science Programs.

Continuous chromotographic separation of nickel, cobalt, and copper was demonstrated. New in-line instrumentation permitted accurate measurements of the resolution between peaks. The effects of fluid viscosity and flow rate on pressure drop and overall efficiencies for removal of kaolin particles by a hydraulic cyclone were measured using a 10⁻ mm Dorr-Oliver hydroclone and slurries containing approximately 5 wt % kaolin in water-glycerin solutions. Increasing viscosity affects the ratio of the underflow rate to the overflow rate as well as decreases the particle removal efficiency. Initial measurements of kaolin particle distributions in the underflow and overflow streams (point efficiencies) are also reported. Studies of agglomeration processes in heavy organic liquids focused on the effects of various components of coal-derived liquids on physical properties important to slurry stability and agglomeration processes. Viscosity, density, and electrical conductivity are affected most strongly by the presence of asphaltenes; they increase with asphaltene addition. A new study of the removal of small particles ($\sim$ 1 μm) from process streams with deep granular beds has been initiated. Initial results for removal of titania particles from mineral oil by a bed of 0.30-cm glass spheres demonstrate that these very small particles can be removed by beds of rather coarse materials in the presence of high electric potential fields. Studies of three-phase fluid beds included measurements of minimum fluidization velocities and phase holdup in 7.62- and 15.2-cm-ID columns. Dimensionless correlations were developed for predicting these parameters. An attempt was made to determine axial dispersion in the liquid phase by measuring residence-time distributions in the column, but response of the measuring apparatus was not rapid enough for accurate results.

30056 (ORNL/TM—6647/V2, pp 2-42) **Chemical engineering research.** Jul 1980.

In Advanced technology section semiannual progress report, April 1, 1978-September 30, 1978. Volume 2. Engineering Science Programs.

Studies of continuous chromatography investigated the separation of iron and aluminum, the two major metal components obtained from acid leaching of coal ash. Acid nitrate solutions (pH = 1.4) simulating diluted leach liquors were loaded on a column of Dowex 50W-X8 and eluted with a solution containing 0.5 M $(NH_4)_2SO_4$ and 0.025 M H_2SO_4. This eluted the iron in one portion of the continuous chromatograph. In the portion of the chromatograph that followed, the eluent was changed to 1 M $(NH_4)_2SO_4$ with 0.025 M H_2SO_4, and the aluminum was removed. Studies of agglomeration processes included measurements of the particle size and zeta potential of solids in coal-derived liquids. Similar measurements were made of carbon black in cyclohexane, a well-characterized system, to test the experimental technique. A new study of filtration in deep granular beds in the presence of electric fields produced promising results indicating that this may be an effective and practical polishing technique for removing the ultrafine (< 1-mm-diam) particles from coal-derived liquids. Simulated studies using 1-mm particles in cyclohexane showed that particle removal efficiencies approaching 100% can be achieved. The removal rate increases with increasing electric field strength and with decreasing liquid velocities. The pressure drop through the beds is very small, and the electric power requirements are essentially negligible. Another new study began investigating the use of high-temperature slagging processes for the purification of recycled metals. A preliminary survey identified the removal of copper from recycled iron-based alloys as a particularly important problem, and contactor development studies were initiated using mercury and water to simulate the fluids of interest.

30057 **Transition metal-mediated desulfurization of aromatic sulfur compounds.** Eisch, J.J.; Im, K.R.; Hallenbeck, L.E. (State Univ. of New York, Binghamton). *Am. Chem. Soc., Div. Pet. Chem., Prepr.;* **25**: No. 2, 224-228(Mar 1980). (CONF-800303—(Vol.25No.2)).

From 179. national meeting of the American Chemical Society; Houston, TX, USA (23 Mar 1980).

The presence of organic sulfur in various coals and crude petroleum stocks constitutes a serious problem in producing environmentally acceptable fuels. Accordingly, a worthy objective of fuel research would be to discover energy-efficient ways of cleaving organic sulfur bonds in coal, petroleum or ther derived liquids, so as to minimize atmospheric pollution caused by organic sulfide or mercaptan contaminants in fuels. Since existing desulfurization procedures generally require elevated temperatures, high pressures of hydrogen and the use of heterogeneous catalysts, a search has been launched for desulfurization processes effective under milder conditions, namely those involving homogeneous transition-metal agents. In order to learn more about the fundamental chemistry of carbon-sulfur bond cleavages by transition metals, we have chosen as substrates those aromatic sulfur compounds that are typical of the stable organic sulfur constituents found in coal tar or petroleum stocks, namely dibenzothiophene (Ia), phenoxathiin (Ib), phenothiazine (Ic) and thianthrene (Id), as well as various open-chain sulfides (Ar-S-Ar) and mercaptans (ArSH). Although some soluble nickel (O) complexes, such as bis (1,5-cyclooctadiene) nickel (O), are unreactive in desulfurization, a change of the ligands about nickel causes a striking rise in reactivity. With the aromatic sulfur heterocycles (Ib-Id), either desulfurization with ring contraction or hydrodesulfurization could be achieved, depending on the reaction conditions (1,2). Recent findings on the mechanisms of these unusual desulfurizations are reported.

30058 **Chemical removal of organic sulfur from coal.** Meyers, R.A.; Hart, W.D. (TRW Systems and Energy, Redondo Beach, CA). *Am. Chem. Soc., Div. Pet. Chem., Prepr.;* **25**: No. 2, 258-261(Mar 1980). (CONF-800303—(Vol.25No.2)).

From 179. national meeting of the American Chemical Society; Houston, TX, USA (23 Mar 1980).

The removal of nearly three-quarters of the organic sulfur content from a high sulfur coal has been demonstrated. Further development of these techniques can be expected to result in even more complete sulfur removal through adjustment of reaction conditions. The pyrite content of coal inhibits the efficient extraction of organic sulfur. Air pollution control standards for coal combustion for power generation can be met using the Gravimelt Processes. Extraction of float coal with KOH/NaOH melt resulted in a product coal containing an average of 0.9 lb $SO_2/10^6$ Btu resulting in an 86% reduction in sulfur from run-of-mile. Treatment of the sink coal for pyrite removal reduces the sulfur content to 4 lb $SO_2/10^6$ Btu. The pyrite removal step could be accomplished with a $Fe_2(SO_4)_3$ leach or by the US Department of Energy Oxydesulfurization Processes. The treated float coal meets many proposed and the currently implemented Standards for New Stationary Sources, while the treated sink coal meets some State Implementation Standards for existing stationary sources.

30059 **Separation technique in a coal deashing process.** Rhodes, D.E.; Baldwin, R.A.; Davis, R.E. (to Kerr-McGee Corp.). US Patent 4,177,134. 4 Dec 1979. Filed date 20 Mar 1978. 14p.

An improved coal deashing process is claimed wherein a feed mixture comprising soluble coal products, insoluble coal products, and deashing solvent at a first temperature level is separated in a first separation zone into a first light fraction and a first heavy fraction comprising the insoluble coal products and some of the deashing solvent through admixing predetermined quantities of an additive with the feed mixture prior to separation to provide an improved yield of recoverable soluble coal products. Alternatively, the additive is admixed with the first light fraction prior to subsequent separations to provide an improved yield of recoverable soluble coal products. 4 figures.

HYDROGENATION

REFER ALSO TO CITATION(S) 30407

30060 (FE—2044-47) **Partial liquefaction of coal by direct hydrogenation. Quarterly progress report, April-June 1979.** Falk, A.Y. (Rockwell International Corp., Canoga Park, CA (USA). Environmental and Energy Systems Div.). 13 Jul 1979. Contract EX-76-C-01-2044. 22p. NTIS, PC A02/MF A01.

Seven additional reactor tests were made in the 1 TPH PDU; two of these were approximately 1 hour in duration. Fourteen tests have now been made with the PDU since the installation of the high-pressure product recovery system was completed. Analysis of results from these tests indicates carbon conversion results consistent with the trends shown in the previous testing. The carbon balance for the first of the 1-hour tests was $\sim$ 95%, with the unrecovered material

assumed to be liquid products. Several operational and hardware problems were encountered which slowed the test frequency somewhat. However, all have been resolved with the exception of char coking or agglomeration which was experienced on Tests 12, 13, and 15. This is thought to be due to failure of some of the oxygen injection tubes in the preburner which could cause hot streaks (poor temperature uniformity) in the hydrogen injection. The new product recovery system appears to be functioning well and as designed. Fabrication of the heat recovery quench unit was completed. Subcontracts for construction of the BTX recovery system and the A-E process study were initiated. A char removal (blowdown) system has been installed on the 1 TPH PDU which, when fully developed, will permit tests to be conducted converting up to 3-1/2 tons of coal.

30061 (FE—3031-3) **Design and simulation of a recirculating bed reactor for coal hydrogasification. Quarterly report, 1 January 1979-31 March 1979.** (Carnegie-Mellon Inst. of Research, Pittsburgh, PA (USA)). May 1979. Contract ET-78-S-01-3031. 36p. NTIS, PC A03/MF A01.

The linear programming analysis has been completed and is highlighted herein. (A special report, to be published shortly, will detail these findings.) Initial flowsheet modelling activity is reported. The modelling is confined to the hydrogasifier section of the plant, and it shows agreement with the linear programming model. The modelling also demonstrates that the failure to crack tars has a deleterious effect on the RBR heat balance. Definition of the design activity for the coal feeding, transport, and injection system has also been completed.

30062 (LBL—10319, pp 4.27-4.31) **Selective hydrogenation of coal.** Grens, E.A.; Vermeulen, T.; Edwards, J.T.; Hershkowitz, F.; Joyce, P.J.; Maienschein, J.A.; Onu, C.O.; Shinn, J.H.; Zieminski, G.H. Feb 1980.

In Chemical process research and development program, FY 1979.

The objective of this project is to convert coal to liquid products by the use of homogeneous catalysts that promote selective scission of certain bonds in the coal structure below coal pyrolysis temperature. The bonds to be attacked are those linking conjugated hydroaromatic groups in the coal, including aliphate bridges and oxygen links (e.g., ether bridges). The catalysts are dissolved in, or constitute, a liquid reaction medium and have access to the extensive interior pore surfaces in the coal. Included in this research program are studies of the interaction of organic solvent media with coals, the effects of homogeneous catalysts in promoting reactions at moderate temperatures, and the use of inorganic Lewis-acid type melts as catalytic media for coal conversion. The action of the catalytic treatments on model chemical compounds containing certain types of bond structures found in coal is examined to elucidate the mechanisms of coal decomposition. Transport processes for coal reaction products and dissolved hydrogen gas are considered to determine the extent to which these processes may limit conversion rates. The project activities planned for 1979 were directed mainly to investigation of the effect of treatment parameters on the conversions of coal in zinc chloride/organic mixed media. The work utilized sub-bituminous coal because of its high reactivity under these treatments. The reaction paths were explored by successive treatments at different temperatures and of fractionated intermediate reaction products. Product analyses and characterization were emphasized to provide insight into the manner by which treatment parameters influence conversion, and proposed reaction mechanisms were treated through model compound studies. Reaction rate studies were also conducted for coal-solvent and coal-melt-solvent interactions.

GASIFICATION

REFER ALSO TO CITATION(S) 30129, 30130, 30135, 30141, 30143, 30157, 30352, 30358, 30597, 30889, 30928, 30931, 30947

30063 **Apparatus for solar coal gasification.** Gregg, D.W. US Patent Application 029,962. [nd]. 15p.

Apparatus for using focused solar radiation to gasify coal and other carbonaceous materials is described. Incident solar radiation is focused from an array of heliostats onto a tower-mounted secondary mirror which redirects the focused solar radiation down through a window onto the surface of a vertically-moving bed of coal, or a fluidized bed of coal, contained within a gasification reactor. The reactor is designed to minimize contact between the window and solids in the reactor. Steam introduced into the gasification reactor reacts with the heated coal to produce gas consisting mainly of carbon monoxide and hydrogen, commonly called synthesis gas, which can be converted to methane, methanol, gasoline, and other useful products. One of the novel features of the invention is the generation of process steam at the rear surface of the secondary mirror.

30064 (ANL—80-5) **Corrosion and mechanical behavior of materials for coal gasification applications.** Natesan, K. (Argonne National Lab., IL (USA)). May 1980. Contract W-31-109-ENG-38. 98p. NTIS, PC A05/MF A01.

A state-of-the-art review is presented on the corrosion and mechanical behavior of materials at elevated temperatures in coal-gasification environments. The gas atmosphere in coal-conversion processes are, in general, complex mixtures which contain sulfur-bearing components (H_2S, SO_2, and COS) as well as oxidants (CO_2/CO and H_2O/H_2). The information developed over the last five years clearly shows sulfidation to be the major mode of material degradation in these environments. The corrosion behavior of structural materials in complex gas environments is examined to evaluate the interrelationships between gas chemistry, alloy chemistry, temperature, and pressure. Thermodynamic aspects of high-temperature corrosion processes that pertain to coal conversion are discussed, and kinetic data are used to compare the behavior of different commercial materials of interest. The influence of complex gas environments on the mechanical properties such as tensile, stress-rupture, and impact on selected alloys is presented. The data have been analyzed, wherever possible, to examine the role of environment on the property variation. The results from ongoing programs on char effects on corrosion and on alloy protection via coatings, cladding, and weld overlay are presented. Areas of additional research with particular emphasis on the development of a better understanding of corrosion processes in complex environments and on alloy design for improved corrosion resistance are discussed. 54 references, 65 figures, 24 tables.

30065 (ANL-FE—49627) **Workshop consensus statement from the 1980 workshop on instrumentation and control for fossil energy processes, January 28-29, 1980, New Orleans, Louisiana .** (Argonne National Lab., IL (USA)). May 1980. Contract W-31-109-ENG-38. 24p. (ANL-FE—49627-TM01). NTIS, PC A02/MF A01.

A workshop on Instrumentation and Controls (I and C) in Fossil Energy Processes was sponsored by the Department of Energy, Fossil Energy in New Orleans, Louisiana, January 28 to 29, 1980. The 82 participants included (approximately): 20% from energy firms (industrial partners), 34% from instrument manufacturers, 12% from architect-engineer and process design firms, 25% from institutions (EPRI, ANL, JPL, etc.), universities and technical societies, and 9% from government. Three major areas of consensus emerged: (1) technical needs, (2) barriers, and (3) communications. Instruments are needed to measure mass flow (solids/gas, solids/liquid), level, high temperature, viscosity, etc. Some needed instruments are unavailable commercially; some have small market, high development cost and risk; operating conditions are generally hostile due to high pressure and temperature, erosion, corrosion, etc. Barriers to I and C technology transfer involve: corporate policy (need to retain patent rights, trade secrets); fear of prosecution by governmental regulatory agencies (Justice, FTC, EPA, etc.) for alleged collusion, restraint of trade, etc.; and fear that candid discussion of I and C problems and deficiencies in plants will lead to loss of funding or job. An ad hoc organization is needed to vigorously pursue communication on I and C between industry and government representatives; and to identify and prioritize I and C needs.

30066 (CONF-800391—1) **Thermochemistry of high-temperature corrosion.** Natesan, K. (Argonne National Lab., IL (USA)). 1980. Contract W-31-109-ENG-38. 14p. NTIS, PC A02/MF A01.

From Environmental degradation of high-temperature materials conference; Isle of Man, UK (31 Mar 1980).

Multicomponent gas environments are prevalent in a number of energy systems, especially in those that utilize fossil fuels. The gas environments in these processes contain sulfur-bearing components in addition to oxidants. These complex environments, coupled with the elevated temperatures present in these systems, generally cause significant corrosion of engineering materials. Thermodynamic aspects of high-temperature corrosion processes occuring in complex gas mixtures are discussed, with emphasis on the role of thermochemical diagrams. The interrelationships between the corrosion behavior of materials and gas composition, alloy chemistry, and temperatures are examined. A number of examples from studies on materials behavior in coal-gasification environments are used to elucidate the role of thermochemistry in the understanding of corrosion processes that occur in complex gas mixtures. 11 figures.

30067 (DOE/ER/04463—T1) **Kinetic and infrared study of the effect of metal crystallite size and metal-support interactions on CO hydrogenation reactions: a third-year progress report.** Vannice, M.A. (Pennsylvania State Univ., University Park (USA). Dept. of Chemical Engineering). 1980. Contract AS02-77ER04463. 26p. NTIS, PC A03/MF A01.

Platinum and palladium supported on four different oxide materials - SiO_2, Al_2O_3, SiO_2-Al_2O_3, and TiO_2 - have been studied in depth. Different preparative techniques were utilized to vary metal particle size and change the state of the metal. For example, Pt and Pd deposited on TiO_2 and reduced at low temperatures (175 to 200°C) exhibit normal adsorption behavior, whereas these same catalysts reduced at a high temperature (500°C) transform into an SMSI (Strong Metal-Support Interactions) state and chemisorption

becomes greatly reduced. Both fresh and used samples were characterized by H_2, and CO chemisorption. In addition, O_2 chemisorption and the H_2-O_2 titration reaction were conducted on most fresh reduced Pt and Pd catalysts to further characterize their adsorption properties and to determine the agreement among these various chemisorption techniques. X-ray line broadening measurements were than conducted on all catalyst samples, and TEM was used to further characterize selected samples, especially the Ni catalysts. Metal loadings were determined by Neutron Activation Analysis. Tables 1 and 2 provide the chemisorption data on Pt and Pd catalysts respectively, and Tables 3 and 4 show the turnover frequencies (N) measured on Pt and Pd dispersed on various supports.

30068 (DOE/ER/10488—1) **Gasification of disordered carbons (chars). Annual Progress Report for Period August 1, 1979-October 31, 1980.** Walker, P.L. Jr.; Jenkins, R.G. (Pennsylvania State Univ., University Park (USA)). Jun 1980. Contract AC02-79ER10488. 72p. NTIS, PC A04/MF A01.

It has been shown that rates of gasification of chars derived from coals vary widely with the rank of coal and the gasification medium used. Variation in rates is thought to be attributable to: (i) variation in active surface area and (ii) extent to which gasification is catalyzed by inorganic impurities present. It is the main objective of this research to confirm this hypothesis for carbons of different morphologies, including disordered carbons (chars). Initially studies are being performed on the carbon-oxygen reaction. This report covers progress in research in three areas: (i) measurement of rate constants for the adsorption step in the reaction of O_2 with a high purity char at low pressures, (ii) design and construction of a high pressure reactor to be used to measure rate constants for the desorption step in the reaction of O_2 with carbons, and (iii) development of small angle x-ray scattering (SAXS) to characterize both dispersion of catalysts supported on carbon and the micropore system of chars.

30069 (DOE/ET/10603—T1) **Phase-equilibria for design of coal-gasification processes: dew points of hot gases containing condensible tars. Final report.** Prausnitz, J.M. (California Univ., Berkeley (USA). Dept. of Chemical Engineering). May 1980. Contract AC01-76ET10603. 142p. NTIS, PC A07/MF A01.

This research is concerned with the fundamental physical chemistry and thermodynamics of condensation of tars (dew points) from the vapor phase at advanced temperatures and pressures. Fundamental quantitative understanding of dew points is important for rational design of heat exchangers to recover sensible heat from hot, tar-containing gases that are produced in coal gasification. This report includes essentially six contributions toward establishing the desired understanding: (1) Characterization of Coal Tars for Dew-Point Calculations; (2) Fugacity Coefficients for Dew-Point Calculations in Coal-Gasification Process Design; (3) Vapor Pressures of High-Molecular-Weight Hydrocarbons; (4) Estimation of Vapor Pressures of High-Boiling Fractions in Liquefied Fossil Fuels Containing Heteroatoms Nitrogen or Sulfur; and (5) Vapor Pressures of Heavy Liquid Hydrocarbons by a Group-Contribution Method.

30070 (DOE/ET/13402—T2) **Synthesis gas demonstration plant program, Phase I. Site confirmation report.** (Grace (W.R.) and Co., Memphis, TN (USA); Ebasco Services, Inc., New York (USA)). Dec 1978. Contract AC02-77ET13402. 540p. NTIS, PC A23/MF A01.

With few reservations, the Baskett, Kentucky site exhibits the necessary characteristics to suggest compatibility with the proposed Synthesis Gas Demonstration Plant Project. An evaluation of a broad range of technical disciplinary criteria in consideration of presently available information indicated generally favorable conditions or, at least, conditions which could be feasibly accommodated in project design. The proximity of the Baskett site to market areas and sources of raw materials as well as a variety of transportation facilities suggests an overall favorable impact on Project economic feasibility. Two aspects of environmental engineering, however, have been identified as areas where the completion or continuation of current studies are required before removing all conditions on site suitability. The first aspect involves the current contradictory status of existing land use and planning ordinances in the site area. Additional investigation of the legality of, and local attitudes toward, these present plans is warranted. Secondly, terrestrial and aquatic surveys of plant and animal life species in the site area must be completed on a seasonal basis to confirm the preliminary conclusion that no exclusionary conditions exist.

30071 (DOE/ET/13402—T4) **Synthesis gas demonstration plant program, Phase I. Trade-off study plan.** (Grace (W.R.) and Co., Memphis, TN (USA)). 9 Nov 1977. Contract AC02-77ET13402. 31p. NTIS, PC A03/MF A01.

This report consists of detailed plans for trade-off studies as follows: gasifier operating pressure, method of coal preparation, air quality control alternatives, and cooling tower optimization. (LTN)

30072 (DOE/ET/13402—T6) **Synthesis gas demonstration plant program, Phase I. Deliverable No. 7D: final report on pilot plant sustained run.** (Grace (W.R.) and Co., Memphis, TN (USA)). 28 Dec 1979. Contract AC02-77ET13402. 86p. NTIS, PC A05/MF A01.

The object of the Type Ic, Extended Pilot Plant Run, was to establish equilibrium conditions in all streams, obtain analytical data from all streams, obtain slag and char physical properties, demonstrate sustained operation with the design coal and confirm the design basis. Based on our initial review of the data obtained from the extended run, the objectives of the run have been met. The extended run confirmed the design parameters used in the Demonstration Plant design with regard to Synthesis Gas composition and quantity, waste streams, and the required coal and oxygen inputs. The Texaco Type Ic Test Report included in this report tabulates this information. The design of the Demonstration Plant was essentially completed before the Type Ic extended test run. As stated, the extended test generally confirmed the validity of the Demonstration Plant design. However, certain factors emerged during the test run that suggest that certain aspects of the Demonstration Plant design should receive particular attention during Phase II of the Demonstration Plant Program. These are listed and described.

30073 (DOE/ET/13402—T7) **Synthesis Gas Demonstration Plant Program, Phase I. Deliverable No. 16. Recommendation and rationale for Demonstration Plant.** (Grace (W.R.) and Co., Memphis, TN (USA)). Apr 1979. Contract AC02-77ET13402. 19p. NTIS, PC A02/MF A01.

The conceptualized design for the Commercial Plant and the results of the economic and environmental evaluations are used as a basis for selecting the process configuration and size of the Demonstration Plant. The processing steps and size selected are those required to verify the technical and economic performance of the conceptualized Commercial Plant. The first part of this section addresses the subject of Demonstration Plant size and the second part discusses the recommended configuration of the Demonstration Plant and reviews the process and/or equipment selection in various parts of the overall process.

30074 (DOE/ET/13402—T7) **Synthesis gas demonstration plant program, Phase I. Deliverable No. 41: technical support plan.** (Grace (W.R.) and Co., Memphis, TN (USA); Ebasco Services, Inc., New York (USA)). 1977. Contract AC02-77ET13402. 4p. NTIS, PC A02/MF A01.

Ebasco, in conjunction with its key subcontractors has developed a Technical Support Program Plan to minimize the high risk areas of the Synthesis Gas Demonstration Plant design. The plan identifies critical areas of the mechanical and process design and includes cost benefit analyses. Ebasco's process subcontractor, Humphreys and Glasgow will be responsible to Ebasco for process engineering, integration of process design, and accountability for process integrity. Humphreys and Glasgow will perform process trade-off studies, identify high risk areas, and evaluate alternatives of process configuration for the Commercial and Demonstration Plants. Humphreys and Glasgow will also make use of vendor and manufacturer assistance where necessary in design systems related to cryogenic applications and acid gas cleanup. Primary gasifier technical support is provided by Texaco at their Montebello pilot plant facility. Confirmation Studies using Design Coal have major activities as described in the text. Areas of the plant identified as involving high risk technology will be investigated and study requirements established. Trade-off studies for several areas have already been identified: gasifier operating pressure, gas purification alternatives, equipment arrangement studies, air quality control system alternatives, coal preparation alternatives, and cooling tower optimization.

30075 (DOE/ET/13402—T8) **Synthesis gas demonstration plant program, Phase I. Trade-off study report III, method of coal preparation.** (Grace (W.R.) and Co., Memphis, TN (USA)). Apr 1979. Contract AC02-77ET13402. 49p. NTIS, PC A03/MF A01.

It is recommended that the design of the Coal Handling System for the Demonstration Plant be based on using equipment similar to, but at one-third of the size of equipment specified for the Commercial Plant. The one major exception to this recommendation involves the barge unloader where it is recommended that for the Demonstration Plant a single grab bucket be used rather than the twin bucket ladder specified for the Commercial Plant. Wet grinding of coal in a rod mill operated in open circuit, using a trommel screen for removal of oversize material is recommended for the conceptual design of the Commercial Plant for the reasons given. The impact of oversized product material on the performance of downstream equipment, and in particular on the ability of the slurry pumps to deliver a consistent volume of slurry has been considered for this study, but its effect has not yet been demonstrated in tests. Conflicting opinions have been expressed by slurry pump vendors as to the maximum slurry top size which can be handled without causing flow interruptions. In consideration of the severe consequence which will occur in downstream processing equipment if the slurry flow is suddenly interrupted, it is recommended that the Demonstration Plant design be based on a system which will more positively eliminate the possibility of oversize material reaching the slurry pumps. The use of an open circuit system involving rod mill grind-

ing, vibrating screening for separation and recycling of 14 plus US mesh material, followed by dewatering facilities should be considered.

30076 (DOE/ET/13402—T9) **Synthesis gas demonstration plant program, Phase I. Deliverable No. 7F: Phases II and III environmental monitoring plans.** (Grace (W.R.) and Co., Memphis, TN (USA)). Jan 1980. Contract AC02-77ET13402. 37p. NTIS, PC A03/MF A01.

The baseline monitoring program established existing conditions at the site from which construction and operational impacts were predicted in the Environmental Report. The purpose of construction and operational programs is to identify and quantify impacts and monitor the effectiveness of selected mitigation measures. The construction and operational programs are a refinement of the baseline monitoring program. The goal is to avoid redundance by monitoring specific activities and areas where impacts could occcur. This includes utilizing data required for permit compliance (air and water discharges and solid waste disposal). A review of the baseline monitoring program was also conducted to determine if data gaps or voids existed in the baseline program which could be filled with a preconstruction monitoring program. The review was conducted in light of the potential impacts from construction and operational activities identified in the Environmental Report. Review of the baseline monitoring program and the Environmental Report indicated the need for some additional data. Therefore, a preconstruction monitoring program has been designed to fill in the data gaps and strengthen the data base for subsequent impact and mitigative measure assessments.

30077 (DOE/ET/13402—T14) **Synthesis Gas Demonstration Plant Program, Phase I. Trade-off studies report V: cooling tower optimization.** (Grace (W.R.) and Co., Memphis, TN (USA)). Dec 1978. Contract AC02-77ET13402. 40p. NTIS, PC A03/MF A01.

The basic results of the economic investigation of rectangular mechanical draft cooling towers for the commercial plant application are tabulated. The results show that the annual costs, adjusted for the influence of cooled water temperature and cooling range on plant equipment costs and performance, follow a well defined pattern. Specifically, we find that for a given design cooled water temperature, costs are reduced when the cooling range (or temperature rise through the plant) is increased. The rate of cost reduction decreases however, indicating an eventual reversal of the trend caused by a rapid increase in the cost of plant equipment designed for high range and high temperatures. It is also noted that costs decrease as the design cooled water temperature approaches the design wet bulb temperature. This trend is due to the influence of plant costs since the trend in cooling tower costs is opposite. An optimum occurs at 83°F cooled water temperature due to rapidly increasing cooling tower costs. The plotted results show that for all cooling ranges up to 35°F, a cooled water temperature of 83°F is the economic choice. This is also the lowest practical choice for cooling tower design. To allow for the specification of plant equipment to accept a cooled water temperature in excess of 83°F, and to allow for some deterioration in tower performance without exceeding 120°F hot water temperature, it is recommended that a range of 30°F be used. Summarizing, it is recommended that the cooling tower be of the conventional rectangular mechanical design and based upon a cooled water temperature of 83°F and a cooling range not to exceed 30°F.

30078 (DOE/ET/13402—T15) **Synthesis Gas Demonstration Plant Program, Phase I. Deliverable No. 7-B. Critical specifications and parameters for the detailed design and construction of the Demonstration Plant.** (Grace (W.R.) and Co., Memphis, TN (USA)). Oct 1979. Contract AC02-77ET13402. 40p. NTIS, PC A03/MF A01.

Paragraph 10, Article (4) I, Technical Direction and Contract Administration of Prime Contract No. ET-77-C-01-2577 states as follows: prior to any mutual determination to proceed to Phase II in accordance with Article (1) VIII above, the Government and the Industrial Partner shall agree to certain critical specifications and parameters to be used in the detailed design and construction of the Demonstration Plant, including, inter alia, the size and materials for major pieces of equipment. Such agreement shall be set forth in writing and shall be signed by the Industrial Partner's Project Director and by the Government's Program Director and Contracting Officer. This document has been prepared to delineate and define the critical specifications and parameters to be used in the detailed design and construction of the Demonstration Plant in accordance with the above and includes the following: major design parameters, design codes and standards, general specifications, specifications of major equipment items, process schematics, flow diagrams, and plot plans and elevations.

30079 (DOE/ET/13402—T16) **Synthesis gas demonstration plant program, Phase I. Trade-off studies report IV, air quality control alternatives.** (Grace (W.R.) and Co., Memphis, TN (USA)). Sep 1978. Contract AC02-77ET13402. 85p. NTIS, PC A05/MF A01.

For particulate removal systems four alternate methods were considered: wet venturi scrubbers, combination of multicyclonic mechanical dust collectors (MDC) and wet venturi scrubbers; electrostatic precipitators (ESP), and baghouses. For sulfur dioxide (SO_2) removal eleven alternate systems were considered: magnesia slurry scrubbing, sodium sulfite scrubbing (Wellman-Lord), ammonia (clear liquor), citrate, phosphate (Aqua-Claus), steam stripping, aqueous carbonate, ammonia (semi-dry), carbon sorption, copper oxide, and catalytic oxidation. On the basis of this investigation it is recommended that a 99.65 percent efficiency ESP/Wellman-Lord System be utilized for this project. The technical and economic bases for this recommendation are given. (LTN)

30080 (DOE/ET/13402—T21(Vol.1)) **Synthesis Gas Demonstration Plant Program, Phase I. Commercial plant conceptual design and evaluation.** (Grace (W.R.) and Co., Memphis, TN (USA); Ebasco Services, Inc., New York (USA)). Mar 1979. Contract AC02-77ET13402. 314p. NTIS, PC A14/MF A01.

This report summarizes the Commercial Plant Conceptual Design and Evaluation for the Synthesis Gas Demonstration Plant Program. The work has been performed in accordance with Contract No. ET-77-C-01-2577 between W.R. Grace and Co. (Grace) and the United States Department of Energy (DOE). The Commercial Plant converts coal to ammonia using a coal gasification process to produce from a high sulfur agglomerating coal a clean fuel gas suitable for use as an industrial synthesis gas. The plant is sized to produce 3500 tons per day (TPD) of ammonia and for the purpose of the conceptual design effort has been assumed to be sited in Baskett, Henderson County, Kentucky. The scope includes development of a conceptual design based on trade-off studies, process descriptions, process schematics, area plot plans, and mechanical, electrical, and civil engineering design requirements. As part of the conceptual design development, a capital and operating budget estimate, operating requirements, technical and economic risk analysis, and an economic and environmental impact evaluation have been prepared. Finally, based on the Commercial Plant conceptual design, Demonstration Plant recommendations are developed to size the plant and provide a configuration that will demonstrate the technical and economic viability of the Commercial Plant. Several plant systems containing proprietary information have been summarized in a non-proprietary form for inclusion herein. However, the development of the budget estimates of delivered and erected cost and operating cost is based on the use of the more detailed (proprietary) technical data.

30081 (DOE/ET/13402—T21(Vol.2)) **Synthesis Gas Demonstration Plant Program, Phase I. Commercial plant conceptual design and evaluation.** (Grace (W.R.) and Co., Memphis, TN (USA); Ebasco Services, Inc., New York (USA)). Mar 1979. Contract AC02-77ET13402. 239p. NTIS, PC A11/MF A01.

30082 (DOE/ET/13402—T21(Vol.3A)) **Synthesis Gas Demonstration Plant Program, Phase I. Commercial plant conceptual design and evaluation.** (Grace (W.R.) and Co., Memphis, TN (USA); Ebasco Services, Inc., New York (USA)). Mar 1979. Contract AC02-77ET13402. 248p. NTIS, PC A11/MF A01.

Volume 3A contains specifications for the following plant areas: coal handling (unloading and reclaiming), coal slurry preparation, CO shift process, ammonia synthesis, sulfur recovery, steam generation, steam distribution, feedwater and condensate systems, air quality control and ash handling. The following areas contain proprietary information and are not included: coal gasification, carbon/ash separation, acid gas removal, nitrogen wash, and air separation. (LTN)

30083 (DOE/ET/13402—T21(Vol.3B)) **Synthesis Gas Demonstration Plant Program, Phase I. Commercial plant conceptual design and evaluation.** (Grace (W.R.) and Co., Memphis, TN (USA); Ebasco Services, Inc., New York (USA)). Mar 1979. Contract AC02-77ET13402. 259p. NTIS, PC A12/MF A01.

30084 (DOE/ET/13402—T21(Vol.4A)) **Synthesis Gas Demonstration Plant Program, Phase I. Commercial plant conceptual design and evaluation.** (Grace (W.R.) and Co., Memphis, TN (USA); Ebasco Services, Inc., New York (USA)). Mar 1979. Contract AC02-77ET13402. 285p. NTIS, PC A13/MF A01.

This volume contains the trade-off study optimizing operating pressure (1200 psig was chosen), gas purification alternatives (Rectisol and Selexol processes were chosen). Coal preparation (wet grinding in a rod mill with trommel screen removal of oversize was recommended), air quality control (a 99.65% efficiency electrostatic precipitator and Wellman-Lord sulfur dioxide removal process were recommended), and for cooling tower optimization, a cooled water temperature of 83°F was the optimum economic choice, with a hot water entering temperature of 118°F. (LTN)

30085 (DOE/ET/13402—T21(Vol.4B)) **Synthesis Gas Demonstration Plant Program, Phase I. Commercial plant conceptual design and evaluation.** (Grace (W.R.) and Co., Memphis, TN (USA); Ebasco Services, Inc., New York (USA)). Mar 1979. Contract AC02-77ET13402. 289p. NTIS, PC A13/MF A01.

This portion of the trade-off study covers the findings and conclusions regarding alternative marketing, technical, and economic advantages of producing elemental sulfur or sulfuric acid from the assumed plant at Baskett, Kentucky. The Combination Plant, which consists of a Claus unit and a single absorption sulfuric acid unit, is recommended for the Commercial Plant for reasons given in the text. The Combination Plant is also recommended for the Demonstration Plant. In this case, the Return on Investment is slightly lower than for the Single Acid Plant; however, the Combination Plant has a lower operating cost per ton, and the same technical advantages outlined above for the Commercial Plant. It is recommended that further work on CO_2 sales analysis be postponed until a start-up date for the proposed plant has been established. Periodic contact should be maintained with those companies which have indicated potential interest in purchasing CO_2 from the proposed plant. This will allow more quantitative analyses of market demand before a decision is made to sell raw gas, build a purification facility, or vent the gas. It is recommended that no further work be done on the ash and slag sales analysis until the ash and slag have been sufficiently characterized. At this point, a decision can be made to further investigate whether market demands justify incorporating load-out facilities into the plant design. Due to the specialized nature of ash/slag marketing, it may be appropriate to obtain the services of an ash/slag marketing organization.

30086 (DOE/ET/13402—T22) **Synthesis gas demonstration plant program, Phase I. Pilot plant test plan.** (Grace (W.R.) and Co., Memphis, TN (USA); Ebasco Services, Inc., New York (USA)). Jan 1979. Contract AC02-77ET13402. 23p. NTIS, PC A02/MF A01.

Section I in Appendix A to Subcontract No. 3 between Ebasco Services Inc. and Texaco Inc. for the Synthesis Gas Demonstration Plant Program provides for pilot plant testing to be performed at Texaco's Montebello Research Laboratory. The Type Ia test consists of laboratory scale screening analyses not considered further here. The Type Ib and Type Ic tests are pilot plant evaluations which are outlined in detail in this document. Each Type Ib test consists of one or two short pilot plant runs during which approximately 6 tons of coal will be gasified at 1200 psig. The object of this test is to confirm the operability of the process with the selected coal, refine the estimates of preferred operating conditions, product gas yield and composition, obtain slag and char properties and establish the basis for a sustained run with the selected coal. Unexpected operating problems will be identified. The Type Ic test will consist of a sustained 14 to 30 day gasification of the design coal at 1200 psig. The object of this test is to establish equilibrium conditions in all streams, obtain analytical data from all streams, obtain slag and char physical properties, demonstrate sustained operation with the design coal and confirm the design basis.

30087 (DOE/ET/13402—T23) **Synthesis Gas Demonstration Plant Program, Phase I. Trade-off studies report No. 1: gasifier operating pressure.** (Grace (W.R.) and Co., Memphis, TN (USA)). May 1978. Contract AC02-77ET13402. 58p. NTIS, PC A04/MF A01.

The conclusions from analysis of the capital cost estimate is that the comparative figures show a minimum cost at about 1200 psig, which is well within the 500 to 1500 psig pressure range where the absolute cost data is of good accuracy. With the use of figures, the trends apparent are presented graphically, while the breakdown of energy consumption, which is responsible for the major portion of operating costs, can be seen. Inspection of the figures shows that total operating cost is at a minimum at 1200 psig gasification pressure, with the values at 500 and 2500 psig being each about 5 to 6% higher than this minimum. As the individual curves for total operating costs and for capital charges each show the same shape, the combination of these two parameters further emphasizes the trend for minimum ammonia production cost to correspond with the 1200 psig gasification pressure case. Production cost is about 9.5% higher than the minimum at 500 psig and about 13.6% higher at 2500 psig.

30088 (DOE/ET/13402—T24) **Synthesis Gas Demonstration Plant Program, Phase I. Deliverable No. 42. Technical support report.** (Grace (W.R.) and Co., Memphis, TN (USA)). Sep 1979. Contract AC02-77ET13402. 22p. NTIS, PC A02/MF A01.

The Demonstration Plant Process and Conceptual Mechanical Design was prepared by Ebasco Services in conjunction with its key subcontractors, Humphreys and Glasgow (H and G) as process subcontractor and Texaco as supplier of the gasification technology. In addition, vendor assistance was obtained in specialized areas such as: the Acid Gas Removal and Nitrogen Wash Systems, the Air Separation System, the Sulfuric Acid Plant and SO_2 Removal from Boiler Flue Gas. This report identifies the technical support provided by H and G, Texaco and the process vendors of specialized systems as outlined in Deliverable No. 41, Technical Support Plan. The findings, conclusions and recommendations, in general, form the basis for the design of the Demonstration Plant. However, in the finalization of the Demonstration Plant Process and Conceptual Mechanical Design, modifications required as a result of the development of additional information were incorporated. The major thrust of the modifications were to increase plant reliability and assure that environmental requirements would be met for all expected modes of plant operation.

30089 (DOE/ET/13402—T25) **Synthesis Gas Demonstration Plant Program, Phase I. Trade-off study report II: gas purification alternatives.** (Grace (W.R.) and Co., Memphis, TN (USA)). Feb 1979. Contract AC02-77ET13402. 62p. NTIS, PC A04/MF A01.

Gas purification must be carried out in two stages for economic and technical reasons. The requirements of the first stage can be met by a Rectisol plant by Lotepro/Linde AG, or by a Selexol unit by Air Products/Allied Chemical. The second stage in either case should be a Nitrogen Wash unit. The Rectisol solvent (methanol) is freely available worldwide. Selexol solvent is obtainable only from single sources in the USA and in Germany, but serious supply problems are not anticipated. Selexol solvent is relatively non-toxic, non-volatile and non-flammable. Although methanol is classified as toxic and flammable, these potential hazards are controlled to acceptable levels of safety by application of standard methods for plant design and operational handling. The alternative gas purification systems have almost identical installed plant cost, but the operating cost of the Selexol system is substantially higher than that for the Rectisol version. This difference is large compared to any advantages of the Selexol process enumerated above. It is recommended that the Rectisol plant offered by Lotepro/Linde AG, plus a Nitrogen Wash unit, should be specified for the Commercial and Demonstration Plant. Before any such plant is ordered the process requirements (particularly concerning effluents) should be defined as exactly as possible.

30090 (DOE/ET/13402—T26) **Synthesis gas demonstration plant program, Phase I. Deliverable No. 28: plans for use and disposition of products.** (Grace (W.R.) and Co., Memphis, TN (USA)). Sep 1979. Contract AC02-77ET13402. 45p. NTIS, PC A03/MF A01.

As part of Phase I of the Synthesis Gas Demonstration Plant Program, plans for marketing all usable products and by-products from the Demonstration Plant and for disposing of all nonusable by-products and waste streams are to be developed. This plan has been prepared to identify the means of disposition of products, by-products and waste streams. The Demonstration Plant has been designed to produce a synthesis gas suitable for use in the production of ammonia. The plant also produces sulfur, sulfuric acid, carbon dioxide, fly ash, bottom ash, and slag. These by-products are discussed in this plan. In addition, all waste streams are identified and the means of disposal discussed.

30091 (DOE/ET/13402—T27) **Synthesis gas demonstration plant, Phase I. Deliverable No. 7C: current working estimates for Phases II and III allowing 7% annual escalation.** (Grace (W.R.) and Co., Memphis, TN (USA)). Dec 1979. Contract AC02-77ET13402. 48p. NTIS, PC A03/MF A01.

The Current Working Estimates for Phases II and III, as described in the Statement of Work for Contract No. ET-77-C-01-2577, were submitted to DOE on October 31, 1979, as Deliverable No. 23. These estimates were presented as fully forward priced based on best estimate escalation assumptions developed by Grace and exhibited in detail in an appendix to Deliverable No. 23. At the request of DOE, the estimate of capital and operating costs applicable to Phases II and III have been recalculated using a seven percent annual escalation factor for all categories of cost. Utilizing the base dollar (February 15, 1979) estimates in accordance with Deliverable No. 23 and allowing the requested seven percent escalation, the Phases II and III costs are summarized. While details of the forward pricing, allocation and cost sharing estimates are presented herein, it should be noted that data supportive of the base capital and operating costs, together with the approved Allocation Method, were presented in Deliverable No. 23 and are not repeated here. Any review of this document should recognize that the seven percent escalation which serves as the basis is as directed by DOE and does not represent Grace's best estimate of the expected costs of Phases II and III. (LTN)

30092 (DOE/ET/13402—T28) **Synthesis gas demonstration plant program, Phase I. Trade-off study VI, by-product sales analysis. Part 1. Sulfur recovery system. Part 2. Carbon dioxide, fly ash, bottom ash and slag.** (Grace (W.R.) and Co., Memphis, TN (USA)). Mar 1979. Contract AC02-77ET13402. 245p. NTIS, PC A11/MF A01.

The objectives of this study were to develop and analyze information to facilitate decision making in regard to by-products from the Commercial Plant. Part 1 of the study investigated the alternative marketing and commercial advantages of producing elemental sulfur or sulfuric acid, the findings to be used with results of a technical and economic analysis to determine the relative desirability of choosing either as a by-product. The principal commercial and marketing input for this portion of the study were provided by review of authoritative published material and by personnel interviews with government, trade association and commercial information sources, including a limited number of major consumers and producers. Compilation and analysis of statistical data and knowl-

edgeable opinions on the following were included: production and consumption trends and future outlook; levels of current and expected future prices; end-use trends and outlook for new uses; geographic consumption patterns; export market and outlook for foreign sales; and other factors related to the present and future supply and demand and effective marketing of the by-products. Technical data were obtained from the commercial suppliers of the processes involved, supplemented by information from producers of the by-products under consideration. The predicted composition and quantity of all gaseous waste streams were used for investigation of by-product potential. Capital investment and operating costs to produce the saleable by-products investigated were developed for each production alternative considered. Operating profits were determined and comparative figures were calculated for net cash flow and return on investment.

30093 (DOE/FE—0002/79/2) **Coal gasification. Quarterly report, April-June 1979.** (Department of Energy, Washington, DC (USA). Div. of Coal Conversion). Apr 1980. 69p. NTIS, PC A04/MF A01.

In DOE's program for the conversion of coal to gaseous fuels both high-and low-Btu gasification processes are being developed. High-Btu gas can be distributed economically to consumers in the same pipeline systems now used to carry natural gas. Low-Btu gas, the cheapest of the gaseous fuels produced from coal, can be used economically only on site, either for electric power generation or by industrial and petrochemical plants. High-Btu natural gas has a heating value of 950 to 1000 Btu per standard cubic foot, is composed essentially of methane, and contains virtually no sulfur, carbon monoxide, or free hydrogen. The conversion of coal to High-Btu gas requires a chemical and physical transformation of solid coal. Coals have widely differing chemical and physical properties, depending on where they are mined, and are difficult to process. Therefore, to develop the most suitable techniques for gasifying coal, DOE, together with the American Gas Association (AGA), is sponsoring the development of several advanced conversion processes. Although the basic coal-gasification chemical reactions are the same for each process, each of the processes under development have unique characteristics. A number of the processes for converting coal to high-Btu gas have reached the pilot plant Low-Btu gas, with a heating value of up to 350 Btu per standard cubic foot, is an economical fuel for industrial use as well as for power generation in combined gas-steam turbine power cycles. Because different low-Btu gasification processes are optimum for converting different types of coal, and because of the need to provide commercially acceptable processes at the earliest possible date, DOE is sponsoring the concurrent development of several basic types of gasifiers (fixed-bed, fluidized-bed, and entrained-flow).

30094 (EPRI-AP—1268) **Refractories for coal gasification and combustion systems.** Vojnovich, T. (Westinghouse Research and Development Center, Pittsburgh, PA (USA)). Jul 1980. 57p. NTIS, PC A04/MF A01.

Information on the state-of-the art of refractories for slagging and nonslagging coal gasification and combustion systems is presented. This information was obtained as part of a program to design refractories for the high temperature erosion/corrosion and slagging conditions found in these systems. Under these conditions the refractories are subject to wear mainly by erosive solids, corrosive gases, or corrosive slags. The conditions leading to wear of the linings are found to be most severe in the slagging gasifiers and combustors; moderately severe in the gas transfer lines and cyclones; and least severe in the fluidized bed reactors based on the experience of pilot and small-scale demonstration plants. Thin refractory linings with substantial water cooling and thick refractory linings with or without water cooling are used in the slagging environments. Silicon carbide and chrome-alumina refractories are the major refractories used in these designs. High purity alumina castable refractories are mostly used for the erosion/corrosion conditions found in fluidized bed reactors, gas transfer lines and cyclones. Fired shapes of alumina or silicon carbide refractories are used instead in gas transfer lines and cyclones where severe wear has been observed. The study indicates the need for improved refractory linings for the slagging and more severe erosion/corrosion environments. Development of improved refractory linings is expected to be useful for gasification systems which may be used by the utilities for the production of electric power in environmentally-clean and cost-effective plants.

30095 (FE—1207-69(Vol.1)) **Gas generator research and development BI-GAS process. Final report, August 19, 1971-October 31, 1979.** (Bituminous Coal Research, Inc., Monroeville, PA (USA); Phillips Petroleum Co., Homer City, PA (USA)). Jun 1980. Contract AC01-76ET10312. 282p. (BCR-L—1037(Vol.1)). NTIS, PC A13/MF A01.

For the past nine years, Bituminous Coal Research, Inc., under contract to the Office of Coal Research, has conducted research and development on systems for the generation of commercially important gases from coal. Major emphasis has been on the development of the conceptual two-stage super-pressure gasifier as evaluated in the Phase I survey and evaluation study for high-Btu pipeline gas production. Continued operation of the 100 lb/hr Stage 2 process and equipment development unit (PEDU) has supplied reliable information for further evaluation of the direct methanation process. Coals ranging in rank from lignite to high volatile A bituminous coal were tested in the PEDU under a wide range of conditions without pretreatment of the coal and without formation of tar in the process. Yields of methane directly from bituminous coal were higher than predicted from consideration of results obtained in previous tests in a smaller reactor. During this report period, effort was devoted to other unit operations; namely, catalytic methanation of the gases from the two-stage gasifier to produce a high-Btu pipeline-quality gas. Emphasis is being placed on the development of those systems not already available commercially and which are not being developed by others. Conventional methanation systems are generally based on nickel catalysts in fixed beds. Because of the severity of the operating conditions and the large amount of heat generated from the BI-GAS synthesis gas, BCR is developing a program based on a dry fluidized-bed methanator using several different types of catalysts. Data processing and data acquisition systems have been developed as a result of the experimental programs conducted.

30096 (FE—1207-69(Vol.1), pp 103-168) **Carbon deposition degradation and regeneration of fluidized methanation catalysts .** Moeller, A.D.; Bartholomew, C.H. (Brigham Young Univ., Provo, UT). Jun 1980.

In Gas generator research and development BI-GAS process. Final report, August 19, 1971-October 31, 1979.

Degradation as a result of carbon deposition and subsequent regeneration of three fluidized bed methanation catalysts, BCR 3631 ($Ni-Cu-Mo/Al_2O_3$), 3766 ($Ni-Mo/Al_2O_3-SiO_2$) and 4189 (Ru-Ni) were investigated. A 14% nickel on alumina catalyst (Ni-A-116) prepared in this laboratory was also included for comparison. Each catalyst was tested for approximately 24 hours in a severe carbon forming environment (450°C, $H_2/CO = 1.3$) at high (377 psia) and low (20 psia) pressure and then regenerated in dilute air or oxygen mixtures. BCR 3631 and Ni-A-116 were pre-sulfided and subjected to the same test at low pressure. BCR 3631 and 3766 were also tested in a similar manner at low pressure in a fluidized bed reactor. Additional measurements included hydrogen chemisorption before carbon deposition and after regeneration and specific rate measurements before and after carbon deposition and after regeneration. Results show that BCR 3766 is more tolerant than BCR 3631 to carbon deposition both at high pressure and in a fluidized bed. BCR 4189 is apparently more tolerant than BCR 3766 to carbon deposition at high pressure. The catalysts studied can be regenerated using air or oxygen. The oxygen treatment appears to produce the best results, even causing several fold increases in activity relative to the fresh catalysts. However, regeneration by these methods results in significant loss of surface area.

30097 (FE—1207-69(Vol.2)) **Gas generator research and development BI-GAS process. Final report, August 19, 1971-October 31, 1979.** (Bituminous Coal Research, Inc., Monroeville, PA (USA)). Jun 1980. Contract AC01-76ET10312. 501p. (BCR-L—1037(Vol.2)). NTIS, PC A22/MF A01.

The BI-GAS Pilot Plant, located in Homer City, Pennsylvania, is a grass-roots facility designed to study a new process for the conversion of coal into pipeline quality gas. This is the first of a series of operating reports designed to describe the activities, present data and conclusions, and to make recommendations appropriate to that operation. This report focuses on the initial operation of the gasifier but also addresses some of the other major process units of the integrated pilot plant. Those areas include coal preparation and gas treating. Other areas which have not yet been addressed are methanation and sulfur recovery. A principal feature of the plant is the 2-stage, entrained-bed, high-pressure (1500 psig max), oxygen-blown, and ash-slagging gasifier unit. In the refractory-lined Stage II, coal is devolatilized by the hot Stage I effluent. Inside the water cooled barrel forming the reaction chamber of Stage I, the recycled char is combusted to form heat and hydrogen for the Stage II reactions, and the ash is converted to a molten slag which exits through a tap hole into the quench section. Pilot plant test summaries are provided for the individual tests. (LTN)

30098 (FE—1514-105) **Advanced coal gasification system for electric power generation. Third quarterly progress report, April 1-June 30 1979.** (Westinghouse Electric Corp., Madison, PA (USA). Advanced Coal Conversion Dept.). 30 Sep 1979. Contract EF-77-C-01-1514. 102p. NTIS, PC A06/MF A01.

A totl of 23 tons of L-60 coke breeze was processed during test TP-020-1 in 67 hours of hot operation. In test TP-020-2, Pittsburgh seam coal was fed directly to both the devolatilizer and the gasifier. A total of 190 hours of hot fluidized bed operation was accumulated on the gasifier, while the devolatilizer operated hot for 145 hours. Following integrated operation, mechanical modifications for oxygen-blown gasifier testing and startup activities for test TP-022 were completed. An acceptable leak rate was achieved on June

18, followed by an extended hot air heatup period to cure the new refractory in the C-119 cyclone. Test TP-022, the first of a series of three oxygen-blown gasifier tests designed to evaluate operability with various coals, determine optimum operating conditions, and expand the data base in general, was initiated and the results will be reported at a later date. In addition to general maintenance and service work, planned modifications were performed in support of integrated testing. The computer program for the heat and material balances around the gasifier-devolatilizer was revised for integrated operation, design specifications were prepared for mist eliminators in the gas outlets of the C-113 and C-122 cooling towers, the total condensables analyzer is being redesigned, and a scale-up design data base is being compiled.

30099 (FE—2729-10) **Alloy catalysts with monolith supports for methanation of coal-derived gases. Quarterly technical progress report, December 21, 1979-March 20, 1980.** Bartholomew, C.H. (Brigham Young Univ., Provo, UT (USA)). 5 Apr 1980. Contract EF-77-S-01-2729. 43p. NTIS, PC A03/MF A01.

During CO adsorption on nickel catalysts at room temperature, significant amounts of $Ni(CO)_4$ were observed to have formed. H_2S poisoning increased $Ni(CO)_4$ formation. In kinetic tests, methane concentration had little effect on methanation rates, while H_2O vapor severely inhibited the reaction. In some cases H_2O vapor deactivated nickel catalysts. In poisoning studies it was determined that H_2S adsorption on Al_2O_3 is very significant; thus H_2S deactivation rates were measured on INCO nickel powder. Ruthenium has an apparent activation energy for methanation of 113 kJ/mol. Considerable deactivation is observed at 600°K and above. If deactivation of the catalyst is considered, there is no shift in apparent activation energy over a wide range of temperature as was seen on Ni.

30100 (FE—3044-T12) **Cryogenic methane separation/catalytic hydrogasification process analysis. Final report.** Cassano, A.A.; Hilton, M.F.; Li, T.C.; Tsao, T.R. (Air Products and Chemicals, Inc., Allentown, PA (USA)). 14 Feb 1980. Contract ET-78-C-01-3044. 356p. NTIS, PC A16/MF A01.

The objective of this program was to recommend the most attractive combinations of acid gas removal methane separation systems for the Exxon Catalytic Coal Gasification (CCG) and the Rockwell Hydrogasification process currently undergoing development supported by DOE. The program was comprised of the following tasks. Screening to define the most promising integration scheme for each gasification process; development of a process flowsheet, heat and material balance, P & ID, equipment specification, utility summary, and plot plan for the process combination selected; and preparation of detailed economic and final report. The results of the study are documented in this report. The evaluations were performed using data supplied by the prime coal gasification contractors and the vendors of proprietary acid gas removal processes. This information, combined with Air Products' in-house capabilities in acid gas and cryogenic separation processses, was used to develop process designs and cost estimates for each integrated system. The design based and economic criteria employed in the study are described.

30101 (MIT—2295T9-15) **Computer-aided industrial process design. The ASPEN project. Fourteenth and fifteenth quarterly progress report, 1 September 1979-29 February 1980.** (Massachusetts Inst. of Tech., Cambridge (USA)). 15 Mar 1980. Contract AT01-76ET10696. 211p. NTIS, PC A10/MF A01.

ASPEN is operational and a production version has been made available for industrial test participants. Changes for improvements or for fixes to problems are being made regularly in response to user inputs. Some catalogued procedures called executives in CMS language at MIT have been implemented for users to allow convenient execution of ASPEN and to print out results. A preliminary User's Manual of about 1000 pages has been prepared. Training materials have been developed for an introductory user course. Three courses have been held and 92 users have attended these. The four principal areas of work during this period were in documentation, instruction, coding and testing. The remaining model abstracts were completed. A description of the input language for the economic evaluation system was completed. This description will ultimately be incorporated in the User's Manual along with supporting documentation. Several demonstration problems, were prepared on cost estimation. A Data Regression System has been completed.

30102 (ORNL—5425) **Costs and technical characteristics of environmental control processes for low-Btu coal gasification plants.** Singh, S.P.N.; Salmon, R.; Fisher, J.F.; Peterson, G.R. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 299p. NTIS, PC A13/MF A01.

Technical characteristics and costs of 25 individual environmental control processes that can be used for treating low-Btu coal gas are given. These processes are chosen from a much larger array of potential environmental control processes because of their likely applicability to low-Btu coal gasification operations and because of the limited scope of this study. The selected processes cover gas treating, by-product recovery, wastewater treating, and particulate recovery operations that are expected to be encountered in coal gasification operations. Although the existence of the Resource Conservtion and Recovery Act of 1976 is recognized, no treatment schemes for solid wastes are evaluated because of the paucity of information in this area. The potential costs of emission controls (by using eight integrated combinations of these 25 environmental control processes) in conceptual low-Btu coal gasification plants are given in an adjunct report titled Evaluation of Eight Environmental Control Systems for Low-Btu Coal Gasification Plants, ORNL-5481.

30103 (ORNL/TM—7206) **Program plan for the AR & TD Fossil Energy Materials Program.** Bradley, R.A.; Judkins, R.R. (comps.). (Oak Ridge National Lab., TN (USA)). Jul 1980. Contract W-7405-ENG-36. 107p. NTIS, PC A06/MF A01.

This program plan for the Department of Energy Advanced Research and Technology Development Fossil Energy Materials Program discusses the background and technical issues relating to the need for research and development on the materials of construction for fossil energy systems. Current projects being sponsored by this program are identified and each project is discussed briefly. Finally, needed programs for each of the fossil energy technologies are discussed. The plan provides for program sponsors, managers, and participants descriptions of the planned research activities in the AR & TD Fossil Energy Materials Program. Summaries of current and recent activities in this program, along with levels of funding, are provided to indicate the emphasis of the program with respect to the developing technologies and perceived materials problems associated with these developing technologies. The identification of needed programs provides participants and potential participants with an indication of anticipated funded activities. The plan focuses the technology development effort of the program on appropriate objectives and will aid in implementing the program in accordance with guidance received from the Department of Energy.

30104 (SAND—80-0847C) **Results of the fourth Hanna field test.** Covell, J.R.; Wojdac, L.F.; Barbour, F.A.; Gardner, G.W.; Glass, R.; Hommert, P.J. (Department of Energy, Laramie, WY (USA). Laramie Energy Research Center; Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 18p. (CONF-800716—13). NTIS, PC A02/MF A01.

From 6. underground coal conversion symposium; Afton, OK, USA (13 Jul 1980).

The second phase (Hanna IVB) of a coal gasification experiment near Hanna, Wyoming, was completed in September 1979. The experiment attempted to link and gasify coal between process wells spaced 34.3 meters apart. Intermediate wells were positioned between the process wells so that the link could be relayed over shorter distances. Reverse combustion linking was attempted over a 22.9-meter and a 11.4-meter distance of the total well spacing. Thermal activity was generally noted in the upper 3 meters of the coal seam during the link. Two attempts to gasify over the 34.3-meter distance resulted in the propagation of the burn front at the coal overburden interface. Post-burn evaluation indicates fractures as major influencing factors of the combustion process. The Hanna IVB field test provided much insight into influence that geologic features have on in situ coal combustion. The influence of these faults, permeable zones, and cleats, on the air flow patterns can drastically change the overall results of a gasification experiment and should be studied further. The overall results of Hanna IVB were discouraging because of the rapid decline in the heating values for the production gas and the amount of coal gasified. With more complete geologic characerization prior to experimentation and proper well completions, it is believed that most of the subsurface operational problems encountered during Hanna IV could have been avoided.

30105 (SRI-PYU—7930) **Shift conversion and methanation in coal gasification: bench-scale evaluation of a sulfur resistant catalyst. Quarterly progress report, April 1-June 30, 1979.** McCarty, J.G.; Meeker, D.; Wise, H. (SRI International, Menlo Park, CA (USA)). Jul 1979. Contract ET-78-C-01-3240. 24p. NTIS, PC A02/MF A01.

Kinetic studies of catalytic methanation in a gradientless reactor represent the first phase of our experimental program. We have examined methanation kinetics at elevated pressures for the iridium-promoted nickel catalyst and compared it to the performance of an industrial nickel methanation catalyst on exposure to syn gas (CO, H_2). In these measurements, covering a pressure range from 60 to 1000 psig at temperatures from 550 to 575°K, the synthesis gas contained up to 25 vol % CO (the remainder was H_2). The kinetics of methanation exhibit negative order with respect to CO and positive order with respect to H_2. The hydrogen effect is particularly pronounced for the Ir-promoted Ni/Al_2O_3 catalyst. The formation of ethane was observed at $H_2/CO < 15$. A series of measurements with catalysts partially deactivated by exposure to H_2S, demonstrated that the Ir-promoted Ni catalyst exhibited much higher activity than the Ni catalyst after the same dosage of the sulfur compound.

30106 **RMA engineering applications to fossil energy projects.** Sims, J.R.; Bellinger, D.Q.; Halili, E.E. (TRW, McLean, Va). *Proc., Annu. Reliab. Maintain. Symp.;* No. 80CH1513-IR), 259-267(1980).

From Reliability and maintainability symposium; San Francisco, CA, USA (22 Jan 1980).

This paper provides information on reliability, maintainability, and availability (RMA) applications to fossil energy projects. It addresses the major considerations and constraints that have evolved as the attempt is made to encompass an increasing number of fossil energy projects. It describes a number of significant current and/or planned implementation activities and summarizes the overall status of such activities and the environment in which they are proceeding. Finally, it provides recommendations for improving the acceptability and utilization of RMA techniques as fossil energy projects progress in direct support of the National Energy Plan. 8 refs.

30107 **Coal gasification plant.** Wood, A. (to British Gas Corp.). US Patent 4,177,042. 4 Dec 1979. Priority date 22 Mar 1977, United Kingdom of Great Britain and Northern Ireland (UK), 6p.

A removable annular hearth member, shaped to fit over the slag outlet of a slagging gasifier, comprises a cast body of high thermal conductivity having integral coolant passageways, said passageways being formed by shaping a metal tube into a coil having an inlet and an outlet, and casting metal to the desired shape around the coil such that the inlet and outlet communicate exteriorly of the cast body. 4 figures.

30108 **Energy promise of unminable coal.** *Compressed Air;* **83**: No. 4, 14-18(Apr 1978).

Low-Btu gas produced at Hanna consists of 4 to 6 percent methane; 45 to 50 percent nitrogen, because air rather than pure oxygen is injected; 12 to 18 percent carbon monoxide; 15 to 20 percent hydrogen; 10 to 15 percent carbon dioxide; small amounts (less than 1 percent) of ethane and propane; and about 0.1 percent hydrogen sulfide. The combustible gases contained in this mixture are hydrogen, methane, carbon monoxide, ethane, and propane, Nitrogen and carbon dioxide have no heating value and simply dilute the ases produced from underground coal gasification (UCG), thereby yielding the low-Btu gas. Injecting oxygen rather than air would achieve a higher Btu gas; no nitrogen would be produced. Plans to do this at Hanna have been made, but the first-generation process is to develop the system using air. Oxygen injection requires stringent safety precautions and preparation not needed during air injection. One of the most promising aspects of UCG is that it lacks those major environmental impacts associated with current coal mining or coal combustion techniques. Large areas of land are not removed from use for any extended periods of time, and reclamation is not a serious problem because the land surface is not disrupted. There are some other advantages: no sulfur oxides are emitted because the sulfur can be scrubbed from the gas before burning it; less-high-quality water is required because the water in the coal regardless of its quality, is used in the process; and, no large amounts of solid wastes are left above ground, all ash is left in the coal seam. However, there will be some environmental impacts. The areas of major concern are the effects of UCG on groundwater quality and the effects of subsidence. The economic feasibility of UCG is purely speculative at this time.

30109 **Coal to gas and rust to iron to rust again.** *Compressed Air;* **83**: No. 4, 24-27(Apr 1978).

The Hygas plant is operating with a steam-oxygen gasifier that is integrated into the gasification reactor vessel. After the coal passes through the gasification process, it falls into the steam-oxygen gasifier into which steam and oxygen are injected. The oxygen in the steam attaches itself to the carbon remaining in the char, becoming carbon dioxide. This leaves behind hydrogen, which then rises through the reactor to perform its function in the gasification process. The oxygen that is injected into the used to produce the heat to keep the whole process functioning. The problem with this arrangement is that while hydrogen is now being produced, the question is where do you get the oxygen? Here enters the steam-iron process, and a proces much more complex than for steam-oxygen. While the first cost of steam-iron equipment would be even more than the steam-oxygen system, IGT researchers hope it will be less costly to operate. There is also the advantage that the hydrogen produced by steam-iron is expected to be purer than steam-oxygen hydrogen, thus requiring less cleanup of the product gas...another money saver. It would also be possible to capture some residual energy from the steam-iron system to produce by-product electricity, but this too would up the initial investment costs.

30110 (DOE/ET/13402—T1(Vol.1)) **Synthesis Gas Demonstration Plant, Baskett, Kentucky: environmental report.** (Grace (W.R.) and Co., Memphis, TN (USA)). [nd]. Contract AC02-77ET13402. 287p. NTIS, PC A13/MF A01.

A summary of the potential environmental impacts of the construction and operation of the proposed plant is presented. The construction and operation of the plant are discussed in detail.

30111 (DOE/ET/13402—T1(Vol.2)) **Synthesis Gas Demonstration Plant, Baskett, Kentucky: environmental report.** (Grace (W.R.) and Co., Memphis, TN (USA)). [nd]. Contract AC02-77ET13402. 678p. NTIS, PC A99/MF A01.

This volume contains chapter 4 and Appendix 4A which include descriptions of use of adjacent land and water (within miles of the proposed site), baseline ecology, air quality, meteorology, noise, hydrology, water quality, geology, soils and socio-economic factors. Appendix 4A includes detailed ecological surveys made in the area including the methods used. (LTN)

30112 (DOE/ET/13402—T1(Vol.3)) **Synthesis Gas Demonstration Plant, Baskett, Kentucky: environmental report.** (Grace (W.R.) and Co., Memphis, TN (USA)). [nd]. Contract AC02-77ET13402. 1078p. NTIS, PC A99/MF A01.

This appendix contains certain data gathered by Ebasco Services Incorporated/Envirosphere during the field studies relative to the Baskett Site. Included in this appendix are the data collected by Envirosphere Aquatic Ecologists during a baseline study of on-site water bodies and the Green River adjacent to and up-river from the site. The on-site bodies, including a stream, three farm ponds, and Cypress Slough were sampled to gather necessary information to describe the population and community structure of the aquatic systems. The data were also used in part as a basis for determining potential impact on the systems affected by construction and operation of the Synthesis Gas Demonstration Project. Also included are data from a quarterly surface water and groundwater quality monitoring program. The data include field sampling and laboratory analyses undertaken to establish seasonal water quality for the period of Fall 1978 through Summer 1979. A field sampling program was conducted to gather hydrological data of in-situ temperature measurement, vertical profiles of current speed, current direction and temperature at specified depths of near bottom, mid-depth and near surface, and detailed bathymetry of the Green River in an area 1500 ft upstream and downstream of the discharge location. Also presented are data gathered by the Ebasco Consulting Civil Department on the Geology, Soils, and Geohydrology of the site area. Air quality/meteorological monitoring data includes carbon monoxide, sulfur dioxide, nitrogen dioxide, ammonia, ozone, wind speed, wind direction, total suspended particulates, total organic and inorganic fractions, total sulfates, trace elements, and polynuclear aromatic hydrocarbons.

LIQUEFACTION

REFER ALSO TO CITATION(S) 30060, 30065, 30101, 30103, 30130, 30157, 30166

30113 (DOE/ET/14800—10) **Exploratory research on solvent refined coal liquefaction. Quarterly technical progress report, April 1-June 30, 1979.** (Pittsburg and Midway Coal Mining Co., Shawnee Mission, KS (USA)). Jul 1980. Contract AC01-79ET14800. 41p. NTIS, PC A03/MF A01.

This report summarizes the progress of the Exploratory Research on Solvent Refined Coal Liquefaction project by The Pittsburgh and Midway Coal Mining Company's Merriam Laboratory for the period April 1, 1979 through June 30, 1979. Experimental work included a number of short residence time runs, but discussion of that work has been delayed until a later report. Experimental work reported focuses on an investigation of the decline in solvent quality experienced by the Wilsonville Pilot Plant during runs in support of the SRC I Demonstration Plant. A four run series was initiated with Wilsonville solvent; both the coal used at Wilsonville (Kentucky 6/11 - Pyro Mine) and Kentucky 9/14 coal from the Colonial Mine were used. The effect of pyrite addition to the Pyro Mine coal was investigated. No solvent quality or coking problems were experienced in the Merriam runs. Significant changes in solvent composition were apparent and equilibrated solvent samples were returned to Wilsonville for solvent quality testing.

30114 (DOE/ET/14800—11) **Exploratory research on solvent refined coal liquefaction. Quarterly technical progress report, July 1, 1979-September 30, 1979.** (Pittsburg and Midway Coal Mining Co., Shawnee Mission, KS (USA)). Jul 1980. Contract AC01-79ET14800. 56p. NTIS, PC A04/MF A01.

This report summarizes the progress of the Exploratory Research on Solvent Refined Coal Liquefaction project by The Pittsburgh and Midway Coal Mining Co.'s Merriam Laboratory for the period July 1, 1979 through September 30, 1979. In a series of experiments with varying feed gas composition, high levels (20 to 40 mol %) of carbon monoxide resulted in a general degradation of operability and reduced oil yields from Powhatan coal (Pittsburgh Seam). Addition of finely divided pyrite to the reactive Powhatan coal had little effect on oil yields although the molecular weight of the distillation residue was apparently decreased. When finely divided pyrite and magnetite were added to the less reactive Loveridge coal (also Pittsburgh Seam), however, a substantial increase in oil yields and product quality was obtained.

30115 (DOE/ET/14876—3) **Catalysts for upgrading coal-derived liquids. Quarterly report, April 1-June 30, 1980.** Crynes, B.L. (Oklahoma State Univ., Stillwater (USA). School of Chemical Engineering). 15 Jul 1980. Contract AC01-79ET14876. 30p. NTIS, PC A03/MF A01.

Five experimental runs were conducted in the newly constructed trickle-bed reactor. The experiments were designed to obtain data on zoned catalyst beds. This new reactor system demonstrated satisfactory performance in temperature, pressure and flow control. High desulfurization and denitrogenation were achieved on both catalysts tested at conditions of 815F, 1500 psig. These catalysts were a CoMo/Al and NiMo/Al. Zoned bed of 50-50 volume percent of the two catalysts tested revealed no advantages with respect to desulfurization, denitrogenation and activity decay. The level of nitrogen removal was initially high, but activity decay was significant over the operational interval of 100 hours. Two experimental runs were completed in the Catalyst Life Test Unit (CLTU) utilizing a liquid containing 50% Synthoil and 50% Raw Anthracene Oil. This fluid has a 0.54 weight percent sulfur and a 1.21 weight percent nitrogen. The catalyst used in this study was a Ni-Mo-Al_2O_3 (Shell 324). The objective of the experiments was to demonstrate the effect of diluting the catalyst bed with a small size inert particle to improve gas-liquid contact and reduce channeling. No difference could be distinguished between the use of particle sizes in the range of 0.25 to 1.00 mm diameter. One run was terminated prematurely because the small particles plugged the catalyst support screens. Precipitous catalyst activity decay was noted for both nitrogen and sulfur removal.

30116 (DOE/PC/30094—1) **Crossed reaction networks in the catalytic hydrodenitrogenation of synthetic liquid fuels. Quarterly report, 1 February-30 April 1980.** Satterfield, C.N.; Hsi, S. (Massachusetts Inst. of Tech., Cambridge (USA)). 1980. Contract AC22-80PC30094. 11p. NTIS, PC A02/MF A01.

We have completed the detailed design of the reactor and complete apparatus for construction in our specific location. We have also started to purchase most of the main equipment items and components of the system. The hydrodenitrogenation reactions will be carried out in a laboratory-scale trickle bed reactor, where the gas phase and liquid phase flow concurrently downward through a fixed bed of catalyst particles while the reaction takes place. The overall process flow sheet is shown.

30117 (EPRI-AP—1425) **Process development for improved SRC options: short residence time studies. Final report.** Kleinpeter, J.A.; Burke, F.P.; Dudt, P.J.; Jones, D.C. (Conoco Coal Development Co., Library, PA (USA). Research Div.). Jun 1980. 160p. NTIS, PC A08/MF A01.

EPRI Research Projects (RP) 1134-1 and 1134-2 were directed toward the development of an improved coal liquefaction technology. Potential process improvements included short contact time coal liquefaction, critical solvent de-ashing, fractionation of liquefaction products, and the selective recycling of certain product fractions. This work was conducted in the laboratories and on continuous bench-scale units of Conoco Coal Development Company (RP1134-1) and Kerr-McGee Corporation (RP1134-2) over a period of approximately three years. The first two phases of this project on the short residence time (SRT) liquefaction of a midwestern bituminous coal were done by Conoco and have been published in EPRI Interim Report AF-1158. The present report is a final comprehensive report by Conoco that not only summarizes the work in EPRI AF-1158 but also reports on the final phase of the work in which Conoco and Kerr-McGee participated in an integrated program to test the concept of recycling certain product fractions to improve liquefaction performance. In this program, cyclic product shipments between laboratories were necessary to allow the test program to be carried out. The results of parallel work done by Kerr-McGee on critical solvent de-ashing and fractionation will be reported later by Kerr-McGee. This project has shown the benefits of recycling light SRC to enhance coal liquefaction performance in either SRT or conventional SRC modes. It has been demonstrated that the operability of a SRT reactor is dependent on liquefaction solvent quality, and that light SRC addition enhances the quality of the solvent. In addition, it was shown that light SRC promoted reaction at lower temperatures.

30118 (FE—2034-19) **Catalytic hydrogenation of coal-derived liquids. Interim report, March 1980-May 1980.** Berg, L.; McCandless, F.P. (Montana State Univ., Bozeman (USA)). Jun 1980. Contract AC01-76ET10495. 30p. NTIS, PC A03/MF A01.

The work on the development of catalysts capable of converting solvent refined coal, SRC-II, into a feedstock suitable for a conventional petroleum refinery was continued. This requires a process which reduces the nitrogen content from the 1.17% in SRC-II to at least as low as 0.3%. A catalyst containing MoO_3, CoO, NiO and WO_3 was evaluated, subjected to an air burnoff to remove the carbon laydown and re-evaluated. It gave acceptable denitrogenation and desulfurization. Two catalysts containing only MoO_3 and CoO were fabricated and evaluated both before and after burnoff with air. They did not perform well after burnoff. Two different base materials were evaluated with no metal loading. The base materials alone fail to give specification denitrogenation. A study of the fate of the nitrogen removed showed that most of it is in the carbon laydown, lesser amounts in the liquid product and the least in the offgases. Somewhat better operation takes place when the SRC-II feed is preheated to 100 to 200°C. A commercial T.C.C. equilibrium petroleum cracking catalyst is not effective in the denitrogenation of SRC-II.

30119 (FE—2233-5/8) **Catalytic activity of coal mineral matter. Final report, January 1976-July 1979.** Hamrin, C.E. Jr. (Kentucky Univ., Lexington (USA). Dept. of Chemical Engineering). Jul 1979. Contract EX-76-C-01-2233. 107p. NTIS, PC A06/MF A01.

Nine coals were selected and two sets of low temperature ash samples were prepared which gave yields ranging from 4.56 for Bruceton coal to 30.1% for Kentucky No. 11 coal. Characterization of the LTAs by x-ray diffraction (XRD), x-ray flurorescence (XRF), thermogravimetric analysis, BET surface area, and pore volume was completed. X-ray diffraction of raw coal samples was also carried out to show that little if any change occurred during low temperature ashing. The catalytic activity for thiophene HDS at equal final catalyst weights and for n-butyl amine HDN on the same basis are given in tables. These results were obtained at 400°C and 1 atm. A statistical analysis of the HDS conversions versus the XRF values showed potassium to give the best correlation with an R-value of 0.62. An even higher R-value of 0.87 ws found for the surface area-conversion correlation. Of the clays tested montmorillonite No. 22 was the most active and its activity exceeded that of the Homestead LTA by 67%. For HDN, surface area also gave the highest correlation followed by the Si and K concentrations. Correlations obtained were slightly below the 95% confidence level for Al, Si, and Ti. The effect of chemical treatment with HCl, H_2O, KCl, and other solutions on the activity was determined. No significant improvement was found for the former three, but a patent application has been filed for a Ni treatment that increased HDS activity 45 times but left HDN virtually unchanged. Iron sulfide catalysts of high surface area (41 m^2/g) and varying S/Fe were prepared by sulfiding hematite under different time, temperature, and gas compositions. The highest conversion of thiophene was found at an atomic ratio of S/Fe = 0.78. LTA pyrite was also found to have significant HDS activity although its surface area was only 2.4 m^2/g.

30120 (SAND—80-1426) **Coal liquefaction process research. Quarterly report for January-March 1980.** Bickel, T.C.; Curlee, R.M.; Granoff, B.; Padrick, T.D.; Stohl, F.V.; Thomas, M.G. (Sandia National Labs., Albuquerque, NM (USA)). Jun 1980. Contract AC04-76DP00789. 59p. NTIS, PC A04/MF A01.

The overall objectives are to: (1) provide a fundamental understanding of the chemistry of coal liquefaction; (2) determine the role of catalysts in coal liquefaction; and (3) determine the mechanism(s) of catalyst deactivation. The program is composed of three major projects: Short-Contact-Time Coal Liquefaction, Mineral Effects, and Catalyst Studies. These projects are interdependent and overlap significantly. We present our results in such a manner that the interrelationships will be clearly seen. The tasks associated with each project are outlined and specific accomplishments described.

PYROLYSIS AND CRACKING

30121 (FE—3167-T4) **Investigation of the devolatilization of coal under combustion conditions. Fourth quarterly report, July 1-September 30, 1979.** Solomon, P.R. (United Technologies Research Center, East Hartford, CT (USA)). Oct 1979. Contract ET-78-C-01-3167. 103p. NTIS, PC A06/MF A01.

This report describes progress in a study of pyrolysis of coal under combustion conditions. Major accomplishments have been thermal decomposition measurements on a number of additional coals, prediction of yields for vacuum pyrolysis, liquefaction with tetralin and hydropyrolysis, further developments of the pyrolysis model to allow prediction of pyrolysis under proximate analysis conditions, the further development of infrared techniques for characterizing functional groups in coals, improvements in the pyrolysis model permitting the simulation of non-isothermal conditions, characterization and comparison of processed and unprocessed coals and design and construction of a new pyrolysis apparatus. The new apparatus will permit experiments with reactive atmospheres and in situ, time resolved measurement of products.

30122 **Electron spin resonance study of the generation of stable arene radical cations in molten antimony trichloride.** Buchanan, A.C. III; Livingston, R.; Dworkin, A.S.; Smith, G.P. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *J. Phys. Chem.;* **84**: No. 4, 423-427(21 Feb 1980).

Pure molten antimony trichloride has been found to act as an oxidizing agent toward polycyclic arenes, producing stable solutions of radical cations. The oxidizing power of the Sb^{3+}/Sb^0 couple has been shown to be considerably increased or decreased by the addi-

tion, respectively, of a few mole percent of a chloride ion acceptor ($AlCl_3$) or donor (Me_4NCl). ESR spectra and coupling constants are reported for several arene radical cations in this medium, including those for the previously unreported acenaphthene radical cation.

BY-PRODUCTS

REFER ALSO TO CITATION(S) 30090, 30092

PROPERTIES

REFER ALSO TO CITATION(S) 30062, 30166, 30951

30123 (DOE/ET/13547—T1) **Hot corrosivity of coal gasification products on gas turbine alloys. Summary report, 15 April 1978-15 November 1979.** Meier, G.H.; Gulbransen, E.A. (Pittsburgh Univ., PA (USA). Dept. of Metallurgical and Materials Engineering). 1979. Contract AC01-79ET13547. 115p. NTIS, PC A06/MF A01.

The results of this investigation have produced mechanisms for the hot corrosion of a number of pure metals and alloys in the types of atmospheres likely to be obtained in turbines using coal conversion products as fuel. The results of these mechanistic studies suggest the following conclusions regarding application of alloys in these situations: (1) Simple Cr_2O_3-forming alloys of both Co and Ni have good hot corrosion resistance to most of the deposits likely to form in turbines burning coal conversion products with the exception of deposits containing considerable amounts of chlorides. (2) The presence of carbide phases is detrimental to the hot corrosion resistance of both Ni and Co alloys. (3) The complex alloy compositions characteristic of superalloys result in susceptibility to hot corrosion, the extent of which is sensitive to salt composition, particularly for Ni-base alloys. (4) Conclusion 3 suggests that uncoated alloys will not be able to provide the require combination of corrosion resistance and high-temperature strength for any of the components in turbines running on coal gas. (5) Several alloys including Co-18Cr-6Al-1Hf, Co-27Cr, Co-20Ni-27Cr, Ni-50Cr, and Fe-18Cr-6Al-Hf have corrosion resistance for use as coatings and claddings at high temperatures (900 to 1000°C). (6) The problem of low temperature hot corrosion (700 to 800°C) must still be investigated for the types of deposits likely to form in coal fired systems before selection of reliable coatings can be made.

30124 (FE—2494-TR-1) **Geochemical study of the inorganic constituents in some low-rank coals.** Miller, R.N.; Given, P.H. (Pennsylvania State Univ., University Park (USA)). Feb 1978. Contract EX-76-C-01-2494. 329p. NTIS, PC A15/MF A01.

Because lignites contain acidic and other functional groups, the inorganic matter associated with them can consist not only of discrete mineral phases but also of cations associated with the organic matter. That much of the inorganic matter can be held in the latter way is likely to have an important influence on the role or fate of inorganic matter in processes utilizing lignites. A number of elements (Ca, Mg, N, K, Sr, Ba, and Mn) were found to be present in all samples largely or partly in ion-exchangeable form, little variation with depth in the seam being observed. In particular, 70 to 90% of the calcium in all samples was ion-exchangeable, so that the formation of calcite deposits in liquefaction reactors is likely to be a general phenomenon when low-rank coals are used. Certain elements (Be, V, Al, Ti, Fe) appeared to be present largely or partly as chelated organic complexes decomposable by acid. Since such complexes will often be soluble in organic liquids, poisoning of liquefaction catalysts by Ti is likely also to be a common phenomenon. A number of elements (Si, Al, K, Mg, Zr, Ti) were largely or partly associated with detrital mineral phases. A variety of trace elements (e.g., Be, V, Cu, Yb, Sc, Ge, Ga), and also acid-soluble Ti, showed major enrichments in the margins of the seams, implying important influences of the organic matter on the trapping of the elements. It also follows that the concentration of a number of elements that may be deleterious to a process or environmentally hazardous could be materially reduced by a selective mining process that rejected, or diverted to other use, a relatively small fraction of a seam near the margins.

30125 (LA—8409-MS) **Qualitative and quantitative x-ray mineralogy: a layman's approach.** Williams, J.M. (Los Alamos Scientific Lab., NM (USA)). Jun 1980. Contract W-7405-ENG-36. 51p. NTIS, PC A04/MF A01.

This report summarizes techniques used for fossil energy samples at LASL to determine their qualitative and quantitative mineral contents. The system for running samples, collecting data, and analyzing the data is semi-automated, and thus allows much flexibility. The programs are written in FORTRAN-IV language for use with Digital Equipment Corporation's RT-11 operating system.

30126 **Characterization of heteroaromatics in coals and coal products.** Winans, R.E.; Scott, R.G.; McBeth, R.L.; Hayatsu, R. (Argonne National Lab., IL). *Am. Chem. Soc., Div. Pet. Chem., Prepr.;* **25**: No. 2, 262-267(Mar 1980). (CONF-800303—(Vol.25No.2)).

From 179. national meeting of the American Chemical Society; Houston, TX, USA (23 Mar 1980).

Heteroaromatics account for a significant fraction of the heteroatoms in coals. The ratio of aromatic to nonaromatic heteroatom content appears to increase in the order O<S<N. The basic heteroaromatic ring systems are established in the lower rank coals while the higher rank coals contain more of the highly condensed derivatives. The gas chromatographs microwave plasma analyzer is proving to be a very useful quantitative tool necessary for this type of investigation.

30127 **Erosion study of different materials affected by coal ash particles.** Tabakoff, W.; Kotwal, R.; Hamed, A. (Univ. of Cincinnati, OH). Contract E(49-18)-2465. *Wear;* **52**: 161-173(1979).

Alloys in contact with coal particles or coal ash are exposed to erosion. The problem of predicting erosion is very complex. The present paper describes the test facility which is designed in such a way that the aerodynamic effects are an integral part of the erosion test parameters. Some results from the alloys studied (aluminum, stainless steel and titanium) in this investigation are reported.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 30079, 30102, 30158, 30196, 30407, 30603, 30606, 30607, 30818, 30944, 31142

30128 (EPRI-CS—1428) **Economic and design factors for flue gas desulfurization technology. Final report.** (Bechtel National, Inc., San Francisco, CA (USA)). Apr 1980. 206p. NTIS, PC A10/MF A01.

A review of nine published FGD cost estimates exhibited wide variations in both estimated and actual FGD costs. These variations often reach factors of three to five times the costs at the lower end of the cost range. The major causes of these cost variations have been determined and standard design and economic assumptions and methodology suggested to reduce their magnitude. Conceptual designs and cost estimates are presented for the limestone slurry, lime slurry, double alkali, Chiyoda Thoroughbred 121, Wellman-Lord, magnesia slurry, absorption/steam stripping/Resox, and the lime slurry/spray drier/fabric filter processes. For both low- and high-sulfur coal applications, the alkali-based nonregenerable processes exhibited the lowest capital and levelized revenue requirements and the lowest parasitic energy consumptions. The Chiyoda Thoroughbred 121 process appears particularly attractive. It exhibits low total capital and levelized revenue requirements and also produces a stackable gypsum byproduct. The spray drier/fabric filter process using a lime slurry is also attractive, but has not yet been demonstrated for high-sulfur coal applications. The economics of absorption/steam stripping and other regenerable processes are adversely affected by high energy consumption, principally for regeneration of the scrubbing reagent. EPRI is evaluating improvements in the absorption/steam stripping/Resox process that could reduce both energy consumption and equipment costs. Generalized cost estimates such as those presented should be used only as comparative estimates for research and development planning and FGD process screening. Since the estimates are based on a specific set of assumptions, it is not appropriate to generalize these estimates or assume they represent manufacturers' current, site-specific selling prices.

30129 (FE—2496-43) **Biological treatment of Hygas coal gasification wastewater.** Luthy, R.G.; Tallon, J.T. (Carnegie-Mellon Univ., Pittsburgh, PA (USA). Dept. of Civil Engineering). Dec 1978. Contract EX-76-S-01-2496. 157p. NTIS, PC A08/MF A01.

An experimental study was performed to assess biological treatability characteristics of Hygas coal gasification process pilot plant wastewater comprised of cyclone and quench condensates. The study evaluated treatability characteristics of ammonia stripped and unstripped wastewater at full strength and at 1:1 dilution. It was determined that minimum pretreatment required for biological oxidation consisted of reducing wastewater alkalinity, and decreasing raw ammonia concentration by dilution or by stripping. Kinetic studies with stripped Hygas wastewater showed the waste could be processed at mean cell residence times varying from 10 to 40 days with hydraulic residence times of 2 to 3 days; the bacteriological yield coefficient was 0.11 (COD basis), and the decay coefficient was 0.02/day. The study also determined correlations for dissolved oxygen uptake, the effect of COD removal rate on zone settling velocity and sludge volume index, removal efficiencies for various constituents, and adsorption isotherms for biological effluent COD on activated carbon and process char. A literature review showed that there are differences in wastewater characteristics between coke plant weak ammonia liquors and high strength coal gasification process effluents. The available data base for design of coke plant biological treatment facilities is deficient; therefore, it is not possible

to transfer other than general observations on biological treatment of coke plant effluents to biological treatment of coal gasification process effluents.

30130 (LBL—10319, pp 4.34-4.37) **Processing of condensate waters from solid-fuel conversion.** King, C.J.; Lynn, S.; Hanson, D.N.; Greminger, D.C.; Burns, G.P.; Mohr, D.H.; Hill, J.D.; Bell, N.E. Feb 1980.

In Chemical process research and development program, FY 1979.

The water formed by condensation from the chemical reactor effluents in the SRC liquefaction and the synthane gasification process was analyzed, phenols were extracted, and NH_3 and CO_2 stripped.

30131 (ORNL/TM—6377/V2) **Advanced technology section semiannual progress report, October 1, 1977-March 31, 1978. Volume 2. Engineering Science Programs.** Watson, J.S.; Clinton, S.D. (comps.). (Oak Ridge National Lab., TN (USA)). Jul 1980. Contract W-7405-ENG-26. 152p. NTIS, PC A08/MF A01.

Separate abstracts were prepared for each of the three sections: chemical engineering research; fusion energy; and resource recovery.

30132 (ORNL/TM—6377/V2, pp 127-144) **Resource recovery.** Jul 1980.

In Advanced technology section semiannual progress report, October 1, 1977-March 31, 1978. Volume 2. Engineering Science Programs.

Investigations of processes for recovering aluminum and other metals from fly ash focused on sinter-leach processes where the ash is first sintered with a low melting salt mixture and then leached with acid. The most interesting of these processes are the salt-soda process which uses a sinter mixture of NaCl and Na_2CO_3 in a ratio of 2:1 and the Calsinter process which uses a $CaSO_4$ and $CaCO_3$ mixture. Both processes can give aluminum yields of better than 90%. The Calsinter process can use flue gas desulfurization (FGD) sludge as a source of $CaSO_4$. This both reduces reagent costs and utilizes another troublesome waste material from coal combustion, FGD sludge.

30133 (ORNL/TM—6647/V2) **Advanced technology section semiannual progress report, April 1, 1978-September 30, 1978. Volume 2. Engineering Science Programs.** Watson, J.S.; Clinton, S.D. (comps.). (Oak Ridge National Lab., TN (USA)). Jul 1980. Contract W-7405-ENG-26. 110p. NTIS, PC A06/MF A01.

Separate abstracts were prepared for each of the three sections: chemical engineering research; hydrogen isotope technology; and resource recovery.

30134 (ORNL/TM—6647/V2, pp 96-100) **Resource recovery.** Jul 1980.

In Advanced technology section semiannual progress report, April 1, 1978-September 30, 1978. Volume 2. Engineering Science Programs.

The Calsinter process, originally designed to use $CaSO_4$ and $CaCO_3$ as sintering reagents, was shown to be effective when flue-gas desulfurization sludge (FGDS) is used as one of the reagents. Studies of the behavior of trace metals in fly-ash processing were initiated; these trace components may be especially important if they are toxic and affect ash disposal. Initial studies of direct-leach processing for coal gasification ash indicate that metal recovery may be less difficult and expensive from these materials than from fly ash. Gasification ashes are not fired to the high temperatures that fly ash is and are more reactive.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 30070, 30076, 30102, 30110, 30112, 30147, 30149, 30155, 30602, 30603, 31115, 31150, 31167, 31230, 31239

30135 (ANL/ECT—7) **Gasification/combined-cycle power generation: environmental assessment of alternative systems.** (United Technologies Research Center, East Hartford, CT (USA)). Nov 1978. Contract W-31-109-ENG-38. 401p. NTIS, PC A18/MF A01.

This report provides a basis for the comparative assessment of the potential performance capability, technological development, and economic and environmental impact associated with the operation of integrated low-Btu coal-gasification/combined-cycle power systems. Characterization of the integrated power system in terms of fuel processing, power production, and auxiliary systems is followed up with comparisons of alternative integrated-plant-design/fuel combinations with reference to the conventional coal-fired power plant, taking into account both economic and environmental factors. The report includes an assessment of the effects of recent regulatory changes on the prospects for integrated power systems and establishes a timetable for the probable commercial development of such systems by the utilities.

30136 (BM-IC—8823) **Surface coal mining reclamation equipment and techniques. Proceedings: Bureau of Mines technology transfer seminars, Evansville, Indiana and Denver, Colorado.** (Bureau of Mines, Washington, DC (USA)). 1980. 83p. (CONF-800666—; CONF-800662—). Bureau of Mines, Washington, DC.

From Bureau of Mines technology transfer seminar; Denver, CO, USA (5 Jun 1980).

The Bureau of Mines Minerals Environmental Technology Program is structured to address environmental impacts by developing cost-effective technology to remove or relieve constraints on domestic mineral production while at the same time protecting our environment. These proceedings consist of papers presented at two Bureau of Mines Technology Transfer Seminars in early 1980 for the purpose of disseminating recent advances in technology related to mined-land reclamation. The goal of this subprogram is to improve postmining land use. Specific objectives of the research projects are to develop new technology and better methods for: contour restoration; segregation, storage, and replacement of topsoil; enhancing and sustaining vegetative cover; and preventing and treating postmining hazards through toxic material isolation and selective overburden handling. Seven papers have been entered individually into EDB and ERA. (LTN)

30137 (BM-IC—8823, pp 2-21) **Reducing costs for recontouring mined land.** Goris, J.M. (Bureau of Mines, Spokane, WA). 1980.

From Bureau of Mines technology transfer seminar; Denver, CO, USA (5 Jun 1980).

The major conclusions drawn from field-testing all of the specialized tools under the P and M-USBM contract follow: (1) the tools designed and tested to work in the short distance relocation range performed satisfactorily and resulted in a 50% reduction in cost and tractor time per acre of mined land leveled and reshaped. Proportional savings in diesel fuel were also experienced. (2) In leveling and shaping normal 90- to 120-ft crest-to-crest spoil banks, the 48-ft angle blade moved approximately 80% of the material while using only 60% of the total tractor time. (3) Conventional bulldozers are needed in the final stages of the land-shaping process. They will move an estimated 20% of the total material but will require approximately 40% of the total tractor time. (4) The 24-ft U-blade showed a 25% increase in production over two separate tractor dozers of comparable horsepower. (5) The deep U-blade demonstrated higher production rates than conventional U-blades in short-distance relocation range below the blade-full point; above this point, the deep U-blade was comparable to conventional blades. (6) The grading bar demonstrated its efficiency in smoothing rough-graded land at rates between 2.5 and 7 acres/h depending on ground conditions. (7) No single tool was effective in all situations. It required the combination of tools to effectively and efficiently level and shape the spoil banks. Based on the results of the P and M-USBM contract, a technology transfer project was funded to demonstrate the tools developed and to show that significant reductions in cost and work efforts could be realized by employing the proper combination of specialized and conventional tools.

30138 (BM-IC—8823, pp 48-53) **Transplanting native vegetation.** Frizzell, E.M. (Bureau of Mines, Spokane, WA); Smith, J.L.; Crofts, K.A. 1980.

From Bureau of Mines technology transfer seminar; Denver, CO, USA (5 Jun 1980).

Advantages of the complete transplanting system, including the transplant bucket and transporter, are: (1) native vegetation can be moved efficiently and economically over longer distances, perhaps several miles, than is possible with the front-end loader (FEL) alone. (2) An FEL, a piece of conventional mine production equipment, would be readily available but would be used only on a limited basis so as not to impede production activities. (3) The transporter could be used continuously without interfering with mine production. Larger areas could be thus transplanted in the same time period. (4) Native vegetation could be removed from an unmined area, placed in a holding area by the FEL, and moved by the transporter to the transplant area when convenient. This will allow maximum productivity with the FEL when it is available and provide increased flexibility in scheduling the FEL. (5) The transporter would be lower in initial cost than an FEL and less expensive to operate. Transplanting costs would therefore be reduced. (6) A truck, large farm tractor, scraper tractor, or other piece of reclamation equipment, not directly required for mine production, could be used to pull the transporter. All power for the transporter operation other than mobility is self-contained, so the prime mover could be changed easily.

30139 (BM-IC—8823, pp 54-59) **Selective overburden placement.** Miller, G.G. (Bureau of Mines, Spokkane, WA). 1980.

From Bureau of Mines technology transfer seminar; Denver, CO, USA (5 Jun 1980).

In the western states, inhibitory materials contain concentrations of salts and trace elements. Salts of calcium, magnesium, and sodium associated with sulfates (SO_4) and carbonates (HCO_3) are present. Trace metal ions of nickel, cadmium, zinc, molybdenum, and lead were a problem at the study site, and levels of copper, manganese, mercury, selenium, and boron should be checked. Suspect levels of pH, ammonium, sand, and clay were found at the site. High concentrations of salts adversely affect plant-water relationships by upsetting the plants' osmotic pressure. High concentrations of trace metals cause metabolic interference in plant cell physiology. Spoils containing more than 40% clay prevent plant root penetration and water infiltration. Clays are usually associated with high levels of positive trace metals ions which cling to negatively charged clay. Spoil containing more than 70% sand retains little water or nutrients essential to plant life. Drinking water contaminated with salts and trace metals causes metabolic problems in animal life. It is desirable to suppress the leaching process in the presence of spoil containing inhibitory concentrations of trace metals or salts. This may be done in four ways: (1) the inhibitory material can be sealed with an impermeable layer; (2) the inhibitory material can be diluted through mixing; (3) a topographic dome can be made above the inhibitory material to divert surface water away; and (4) subsurface water can be consumed by plantlife. Clay seals and dilution were investigated in this project.

30140 (CONF-7811168—) **Report of a contractor meeting-workshop: review and development of biotesting programs for energy utilization.** Stapleton, G.E.; Ts'o, P. (Department of Energy, Washington, DC (USA); Johns Hopkins Univ., Baltimore, MD (USA)). Jul 1980. 69p. NTIS, PC A04/MF A01.

From Workshop on review and development of biotesting programs for energy utilization; Boca Raton, FL, USA (11 Nov 1978).

Periodic program reviews are needed to establish the current state-of-knowledge resulting from research efforts and to reevaluate information needs based on recent progress. On November 11 to 14, 1978 such a review was convened in Boca Raton, Florida to evaluate a major segment of the EV-OHER program devoted to Short-Term Biological Characterization of Potentially hazardous Chemical Agents in Complex Materials Used or Produced in Non-Nuclear Energy Technologies. The sessions for in-depth discussions included: chemicals separation and analysis; new biotesting methods under development; and development of a human risk assessment system.

30141 (DOE/ET/13402—T5) **Synthesis gas demonstration plant program, Phase I. Deliverable No. 26: environmental report outline.** (Ebasco Services, Inc., New York (USA)). 10 Jul 1978. Contract AC02-77ET13402. 32p. NTIS, PC A03/MF A01.

30142 (FE—8977-T1) **Investigation of mechanics of mine acid formation. Volume 1.** Paciorek, K.L.; Kimble, P.F.; Vatasescu, A.L.; Toben, W.A.; Kratzer, R.H. (Ultrasystems, Inc., Irvine, CA (USA)). Mar 1980. Contract ET-78-C-01-8977. 142p. NTIS, PC A07/MF A01.

The objective of the contract was to determine, by the combination of laboratory experiments and mine samplings, the kinetics and mechanisms of the various reactions that produce mine acid drainage. To achieve this goal, primary investigations were performed utilizing pure iron disulfide in the form of pyrite and marcasite, free from coal. The effects of temperature, concentration, surface area, media nature, oxygen, presence of additional ions and bacterial action with respect to dissolution rates were measured. Thiobacillus ferrooxidans and T. thiooxidans were included in this study, both as purchased cultures and freshly isolated from mine samples. Mine samplings were performed to determine the type and quantity of bacteria present, the effect of weathering upon coals' propensity to produce acid and other drainage, the effect of other minerals and the nature of the mine water upon ion liberation, and the effect of the different kinds of bacteria upon the above process. It was established that both pyrite and marcasite, provided sufficient surface area is exposed, will produce hydrogen, sulfate, and iron ions. This process is accelerated in the case of pyrite and marcasite by the presence of T. ferrooxidans and ferric ions. T. thiooxidans accelerates marcasite solubilization and the dissolution of iron disulfide present in coal, but had no effect on museum grade pyrite.

30143 (PB—299040) **Health and environmental effects of coal technologies.** Brown, R. (ed.). (Mitre Corp., McLean, VA (USA). METREK Div.). Aug 1979. Contract AC01-79EV10018. 517p. (DOE/HEW/EPA—04; MTR—79W0015901). NTIS, PC A22/MF A01.

President Carter directed the Secretary of Energy, the Secretary of Health, Education, and Welfare, and the Administrator of the Environmental Protection Agency to establish a joint program to identify the health and environmental problems associated with advanced energy technologies and to review the adequacy of present research programs. Representatives of the three agencies formed the Federal Interagency Committee on the Health and Environmental Effects of Energy Technologies. The MITRE Corporation, Metrek Division, is the Executive Secretariat for the Committee. The goals of this Committee are to review and identify specific health and environmental issues and potential problems associated with the development and commercialization of conventional and advanced energy technologies, to identify the information required to resolve the uncertainties of relevant impacts, to specify research projects to provide such information, and to review the adequacy of current Federal research with respect to these projects. To attain these goals, the Committee is sponsoring a series of workshops, establishing working groups, and initiating other approaches to address the health and environmental consequences of energy technologies. This report provides technology descriptions and characterization of air emissions, water effluents, and physical disturbances associated with coal-based technologies. The material was prepared as background information for use by the working groups for conventional and advanced coal technologies.

RESERVES AND EXPLORATION

30144 (EPRI-EA—673(Vol.3)) **Coal resource information. Volume 3. Case studies in evaluating adequacy of information: Campbell County, Wyoming, and Pike County, Kentucky. Final report.** Klein, D. (ICF, Inc., Washington, DC (USA)). Mar 1980. 267p. NTIS, PC A08/MF A01.

This report describes the results of Task 3 of a multifaceted project to catalogue and evaluate coal resource information. This third task illustrates and evaluates the availability and quality of coal resource information at a detailed level for two contrasting counties: Campbell County, Wyoming, and Pike County, Kentucky. In order to evaluate the completeness of coverage of information, this task considers the information that exists on the coal resources of the case study regions relative to the information needs identified in an earlier task. The quality of available information on the coal resources of the region is then evaluated. This procedure involves identifying the raw data employed and evaluating it and the techniques used to gather it. The case studies are developed as separate, stand-alone studies. The findings applicable to each case study are summarized in the studies themselves. In addition to these case-specific findings, there are also findings of a broader nature which tend to be relevant to coal resources in general. These general findings are summarized as follows: (1) the quantities of estimated coal reserves can both rise and fall over time due to influences of geologic knowledge, resource depletion and, to a lesser extent, economic criteria; (2) existing data are plentiful but incomplete, and not all existing relevant information is incorporated into present and resource estimates, e.g., the US Bureau of Mines Demonstrated Reserve Base; (3) publicly available information is of limited use to the detailed assessment of coal mineability; (4) information on coal quality is much less extensive than that of coal quantity; and (5) no simple relationship governing the distribution of coal tonnages versus seam thickness has been demonstrated.

30145 (EPRI-EA—1360) **Revised coal resource estimates: four case studies. Final report.** Klein, D.E. (ICF, Inc., Washington, DC (USA)). Mar 1980. 212p. NTIS, PC A10/MF A01.

This report presents analyses undertaken to revise coal resource estimates for modeling purposes. The areas covered herein are Illinois, Texas lignite, Alaska, and Campbell County in Wyoming. In ICF's Coal and Electric Utilities Model (CEUM), the coal supply curves are developed as a function of coal reserves and mine-costing algorithms. The slope and length of the coal supply curves depend upon the coal reserve data and the assumptions used to allocate the reserves across mine-types. In CEUM, the source of the coal reserve data is the Bureau of Mines Demonstrated Reserve Base (DRB). The DRB is generally considered to be the most comprehensive set of coal reserves data available which covers the entire US. However, it has some distinct characteristics and weaknesses which limit its usefulness for modeling and forecasting. As a response to these actual or potential weaknesses in the DRB, this study seeks to improve upon the coal resource estimates used in our modeling work. Here we are seeking to refine the shapes of the coal supply curves as well as extend them to include less economic resources. In refining the shapes of the coal supply curves, the emphasis is on non-tonnage information; e.g., overburden ratios, seam thickness, coal quality, etc. In extending the coal supply curves, the emphasis is on incorporating less desirable and/or certain resources which are not included in the DRB. Illinois, Texas lignite, Alaska, and Campbell County in Wyoming were selected as the initial areas for analysis for several reasons. Each area has large coal resources, and future production from these regions is highly sensitive to several factors. Production from these regions also has a major impact on the production from other regions. Finally, for each area, additional information is known to be available, and which could substantially improve the accuracy and/or completeness of the DRB estimates.

MINING

REFER ALSO TO CITATION(S) 30136, 30137, 30138, 30139, 30142

30146 (BM-IC—8823, pp 22-29) **Design considerations of terrace-pit mining.** Miller, G.G. (Bureau of Mines, Spokane, WA). 1980.

From Bureau of Mines technology transfer seminar; Denver, CO, USA (5 Jun 1980).

A dragline is the least expensive method to strip overburden where simple digging and casting are used. However, deep overburden, dipping seams, faulted seams, multiple seams, thin interburden, and toxic materials make dragline mining procedures very complex, and in any of these situations it is questionable whether dragline stripping is the best mining method. Other mining equipment such as shovels, bucket wheel excavators, scrapers, and backhoes may be better. Such equipment is best used where benches or terraces must be constructed to reach a deep coal seam.

30147 (BM-IC—8823, pp 60-73) **Premining hydrologic conditions of five southeastern Ohio watersheds.** McIntosh, G.E. (Bureau of Mines, Denver, CO). 1980.

From Bureau of Mines technology transfer seminar; Denver, CO, USA (5 Jun 1980).

Because of the need for more knowledge on how a surface mine affects its surroundings, the Bureau of Mines has established a study with the US Department of Agriculture - Science and Education Administration - Agricultural Research (USDA-SEA-AR) and the Ohio Agricultural Research and Development Center (OARDC) to: (1) obtain and analyze hydrologic and water quality data from four treatment watersheds, 30 to 60 acres in size, scheduled for mining of different coal seams. Obtain and analyze hydrologic and water quality data from erosion and treatment plots and a control watershed. (2) Characterize the study watershed and plots, and obtain physical and chemical data for the soils and overburden materials prior to surface mining and for the replaced topsoil and underlying spoil material following surface mining. (3) Describe the hydrogeology of the watersheds and the water quality characteristics of the aquifer systems before and after surface mining, and develop or adapt a ground-water model for simulations of the ground-water flow conditions and movement of solutes before and after surface mining. This research program was started in January 1976, and completion is planned for January 1983. This paper deals with the premining hydrologic conditions of the watersheds.

30148 (BM-IC—8823, pp 74-80) **Dragline cable removal project.** Derby, G.K. (Bureau of Mines, Spokane, WA). 1980.

From Bureau of Mines technology transfer seminar; Denver, CO, USA (5 Jun 1980).

During a routine visit by a Bureau of Mines representative to a surface coal mine using draglines for overburden removal, a drag cable broke. When inquiries were made about how repairs would be accomplished, the cannon method of socket and wedge separation was explained. During the discussion, the service personnel stated that they considered removing the cable in this way to be efficient but hazardous, and that they felt relieved when the task was completed without an accident or an injury. This concern was reiterated at other mines and in discussions with industry representatives. Upon further investigation, it was discovered that although socket and wedge separation is the predominant method of performing the task in the United States, it has been outlawed in Canada owing to its inherent hazards. The objectives of the project reported herein included gathering data to determine the level of force required to separate wedge and socket cable terminations of various sizes and makes of draglines, establishing the level of forces generated by the cannon method, and using the data compiled to improve or create new methods and equipment for cable removal.

30149 (BM-IC—8823, pp 30-47) **Topsoil rock removal.** Brady, T.M. (Bureau of Mines, Spokane, WA); Kaufman, W.W.; Reynolds, D.N. 1980.

From Bureau of Mines technology transfer seminar; Denver, CO, USA (5 Jun 1980).

An important element of surface mining reclamation is topsoil since its quality is critical for obtaining successful revegetation of reclaimed land. In most surface mines, scrapers are used for topsoil removal, stockpiling, and redistribution. After topsoil redistribution, the soil must be prepared for revegetation or use as farmland. If the disturbed soil contains too many large rocks, farmland will not be as productive as originally. Farming in areas where no care has been taken to remove large rocks may result in damaged farm equipment and less water permeability, and in smaller, less desirable harvests. To ensure that the soil maintains its productivity and permeability, many States have enacted laws and policies to control the size and quantity of rock in the topsoil. On the Federal level, the Office of Surface Mining (OSM) has established strict regulations governing revegetation of the reclaimed areas. Removing rocks from the topsoil is a fairly easy task; however, maintaining productivity levels is much more complex, requiring years of monitoring. After topsoil redistribution, the soil must be prepared for revegetation. If there are too many large rocks in the topsoil, graders may be used to eliminate them prior to revegetation. Since this method does not penetrate the soil, it is often inadequate and does not comply with many regulations. When deeper penetration is desired, rock rakes attached to dozers are employed. Rakes can eliminate large rocks to depths of 18 inches and deeper, but do not remove the smaller rocks less than 6 inches in size. While the spacing of tines on rock rakes is easily adjustable, if the tines are spaced too close, the soil will be pushed in front of the dozer and rocks will not be eliminated. Since graders and rock rakes are not totally effective for rock removal, some mining companies have elected to use rock pickers.

30150 (DOE/ET/12530—T1) **Demonstration of shield-type longwall supports at York Canyon Mine of Kaiser Steel Corporation. Final technical report A.** Lawrence, R.G.; King, R. (Kaiser Steel Corp., Oakland, CA (USA)). Apr 1980. Contract AC01-74ET12530. 194p. NTIS, PC A09/MF A01.

This report represents work on a program that was originated by the USBM of the Department of the Interior and was transferred to the Department of Energy on October 1, 1977. A demonstration with the Government funded Hemscheidt 320 HSL caliper type shield supports was conducted at three longwall panels of Kaiser Steel Corporation's York Canyon Mine. The purpose of this longwall demonstration was to provide the US coal industry with information on all aspects of shield longwall mining in high seams. The demonstration provided a working model for the coal industry and during the project, 350 people from the industry, schools, and government agencies visited the demonstration. They were provided with a first hand knowledge of a working shield longwall. The demonstration showed that the control of large coal lumps may be a problem in the mining of coal seam thicker than 8 feet. Mining with shield type supports provided good working conditions and a safe working environment. The shield requires very little maintenance and has a high mechanical availability.

30151 (FE—9016-T1) **Demonstration of a steam-powered face haulage vehicle. Final technical report, 31 December 1978.** Demler, R.L. (Foster-Miller Associates, Inc., Waltham, MA (USA)). Jul 1979. Contract ET-75-C-01-9016. 335p. NTIS, PC A15/MF A01.

This program tested and evaluated the exhaust emissions, productivity and economics of a steam engine driven coal shuttlecar. Ninety percent of United States underground coal is presently hauled with shuttlecars, typically electric cable or battery driven. Diesel shuttlecars are not widely accepted in United States coal mines because of exhaust emissions concerns despite their productivity, accident, and economic advantages over electric shuttlecars. The steam engine is attractive due to its low exhaust emissions. The steam engine tested was a modification of an automotive steam engine sponsored by the Environmental Protection Agency (EPA) and the Department of Energy (DOE). Modifications proven with a 75 hp engine include limited surface and air temperatures, exlosion proofing, flame arresting and a 22-in. high engine for the shuttlecar. Development delays, primarily in transducer reliability precluded vehicle testing within the period of performance. Sufficient testing was completed for a proof-of-principle demonstration. A new shuttlecar was completed and successfully tested with a diesel engine. The new shuttlecar concepts have been incorporated in production diesel shuttlecars. The study concludes that a steam engine driven shuttlecar is competitive with the diesel except that the first cost is higher. The steam shuttlecar appears to be superior in all respects to electric shuttlecars. Continued development of the steam engine shuttlecar is recommended if the ultimate acceptability of the diesel is in doubt.

30152 (FE—9058-1(Vol.1)) **Study of the effect of web variation on the performance of a longwall face. Final technical report, 30 November 1979.** Guay, P.J.; Hawkes, T.M. (Foster-Miller Associates, Inc., Waltham, MA (USA)). 30 Nov 1979. Contract ET-77-C-01-9058. 194p. NTIS, PC A09/MF A01.

This report presents the benefits that can be derived from mining deeper webs (cuts) on a retreat longwall as practiced in the United States. The study looks at the increases in productivity (tons per shift and per annum) and the cost benefits (reduced cost per ton off the face) for a double ended ranging drum (DERD) shearer operating in the half face or modified half face mode. The gains in productivity and the cost benefits are established for web depths varying from 27 to 5/ in. in a 6.5 ft seam height. The impact of wide webs on face equipment is evaluated including all currently used types of roof supports, and sizes of shearing machines. Additionally, the expected effect of wider webs on health and safety is discussed, as well as the experience that the British Mining Industry has had mining one meter (39 in.) webs. Finally, the most cost effective system of equipment is identified and specified along with the overall impact of its use on conditions of mining.

30153 (FE—9058-1(Vol.2)) **Study of the effect of web variation on the performance of a longwall face. Final technical report (Appendices), 30 November 1979.** Guay, P.J.; Hawkes, T.M. (Foster-Miller

Associates, Inc., Waltham, MA (USA)). 30 Nov 1979. Contract ET-77-C-01-9058. 98p. NTIS, PC A05/MF A01.

30154 (JPL-PUBL—80-49) **Intergenerational equity and conservation.** O'Toole, R.P.; Walton, A.L. (Jet Propulsion Lab., Pasadena, CA (USA)). 15 Jun 1980. Contract AI01-76ET12548. 29p. NTIS, PC A03/MF A01.

The issue of intergenerational equity in the use of natural resources is discussed in the context of coal mining conversion. More precisely, the authors attempt to determine if there is a clear-cut benefit to future generations in setting minimum coal extraction efficiency standards in mining. It is demonstrated that preserving fossil fuels beyond the economically efficient level is not necessarily beneficial to future generations even in terms of their own preferences. Setting fossil fuel conservation targets for intermediate products (i.e. energy) may increase the quantities of fossil fuels available to future generations and hence lower the costs, but there may be serious disadvantages to future generations as well. For example, the use of relatively inexpensive fossil fuels in this generation may result in more infrastructure development and more knowledge production available to future generations. The value of fossil fuels versus these other endowments in the future depends on many factors which we cannot possibly evaluate today. Thus, since we have no idea of whether we are helping or harming future generations, the authors recommend that intergenerational equity not be used as a factor in setting coal mine extraction efficiency standards, or in establishing requirements.

30155 (SAND—80-7098) **Stress and failure evaluations associated with selected coal mine pillar geometries.** Advani, S.H.; Min, O.K.; Lee, J.K. (Ohio State Univ., Columbus (USA). Dept. of Engineering Mechanics). Jun 1980. Contract AC04-76DP00789. 49p. NTIS, PC A03/MF A01.

The objectives of the Fossil Energy Subsidence Program being conducted by the Sandia Laboratories are (1) to develop a predictive capability for determining the subsidence and resulting damage from underground coal mining as a function of mining plan and geologic site characteristics; and (2) to develop economical methods for preventing or mitigating potential damage. The pillar stress and failure evaluations reported here are an integral part of the Sandia Laboratories program which is currently focused on examing near-field effects at the mining surface and subsequent response propagation to the ground surface. The structural design of coal mine pillars requires the specification of in-situ stresses, assumed constitutive properties of the coal and adjacent strata, and selected system geometry. A recent study by Pariseau and Sorensen provides two-dimensional and three-dimensional stress concentrations and factors of safety for limited geometries using finite element model analysis. This comprehensive study details stress evaluations, using a developed in-house finite element code, for several two-dimensional and three-dimensional geometries. Equivalence between the two-dimensional and three-dimensional stress responses is established using suitable failure criteria. This equivalent is illustrated in terms of conversion design curves which transform a three-dimensional simulation to a corresponding two-dimensional case with the same failure threshold.

30156 **How to calculate optimum longwall length.** Tsuruoka, Y.; Shikasho, M. *World Coal;* **6**: No. 3, 30-1(Mar 1980).

To determine the optimum length of a longwall face, to minimize the cost of mining, certain criteria must be considered. The cost per ton (coal output) of longwall mining may be classified in terms of the face length as follows: (1) Proportional to the face length: depreciation cost and maintenance; (2) Inversely proportional to the ace length; and (3) Unrelated to face length. On this basis costs are developed as a function of face length and minimized. As seen in Figure 1, the bottom portion of the curve for face costs is comparatively stable so that in actual operating circumstances in Japan a face length of between 130 and 180 metrs would normally be adopted. Optimum face lengths adopted in other countries may vary considerably from those acceptable in Japan, especially if equipment, material, maintenance, operating, and wage costs are substantially different from those in Japan. The formulae presented in this article will give the reader a means of determining optimum ace lengths for his own particular conditions.

TRANSPORT AND HANDLING

REFER ALSO TO CITATION(S) 30075, 30143

30157 (ORNL/SUB—79/45724/1) **Conceptual flow sheets development for coal conversion plant coal handling-preparation and ash/slag removal operations.** (Bechtel National, Inc., San Francisco, CA (USA)). Jul 1979. Contract W-7405-ENG-26. 236p. NTIS, PC A11/MF A01.

This report presents 14 conceptual flow sheets and major equipment lists for coal handling and preparation operations that could be required for future, commercial coal conversion plants. These flow sheets are based on converting 50,000 tons per day of clean coal representative of the Pittsburgh and Kentucky No. 9 coal seams. Flow sheets were used by Union Carbide Corporation, Oak Ridge National Laboratory, in a survey of coal handling/preparation equipment requirements for future coal conversion plants. Operations covered in this report include run-of-mine coal breaking, coarse coal cleaning, fine coal cleaning, live storage and blending, fine crushing (crushing to top sizes ranging from 1/4-inch to 20 mesh), drying, and grinding (70 percent minus 200 mesh). Two conceptual flow sheets and major equipment lists are also presented for handling ash or granulated slag and other solid wastes produced by nine leading coal conversion processes. These flow sheets provide for solid wastes transport to an environmentally acceptable disposal site as either dry solids or as a water slurry.

30158 **Unleashing a black beauty.** *Compressed Air;* **83**: No. 4, 5-11(Apr 1978).

In summary, even though the diversity and quantity of desulfurization research are considerable, the obvious conclusion is that an economically desirable method has not yet been perfected. It should be noted, too, that various energy users will require solutions tailored to their own r gonal and specific needs. While all available solution add conside ably to the cost of coal, there are an increasing number of alternativ ways to use coal in an environmentally acceptable way. As advances are made, the cost of meeting EPA standards will likely decline. While it would be a great service to national interests if some researchers developed a sudden breakthrough that made coal cleaning economical, the methods of testing new processes and winning support from utilities and industries will necessarily be slow. Thus, no dramatic cost-reducing alternatives developed at this time are expected to lead to widespread use of a new process in new installations until at least 1990.

COMBUSTION

REFER ALSO TO CITATION(S) 30094, 30103, 30143, 30158, 30601, 30607, 30818, 30976, 31078

30159 (ANL/CEN/FE—79-13) **Regeneration of sulfated limestone from FBCs. Annual report, October 1978-September 1979.** Johnson, I.; Moulton, D.S.; Nunes, F.F.; Swift, W.M.; Teats, F.G.; Jonke, A.A. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 61p. NTIS, PC A04/MF A01.

These studies are concerned with the development of processes for the regeneration of sulfated limestone from fluidized-bed combustors. The results of cyclic combustion/regeneration experiments on three limestones are reported. The reactivity of a low-reactivity limestone, Germany Valley, did not change significantly during cyclic combustion/regeneration. Studies of a high-reactivity limestone, Greer, at lower regeneration temperatures (1050°C) indicated an apparently better performance than at 1100°C. The sorbent utilization of type 2203 limestone in a three-cycle experiment was similar to that of Greer. The results of studies of a process for the recovery of elemental sulfur from SO_2 involving reaction with fly ash or coal ash-coal combinations are reported. The residual carbon in the fly ash was found to be an effective reductant for the SO_2 and high-purity sulfur was obtained. Regeneration of spent limestone sorbent in externally fired rotary kilns was accomplished, but only under conditions that resulted in rapid attack of the kiln materials by SO_2.

30160 (DOE/ET/13011—10) **700, 100, and 20 hp combustion test facility yearly activity report for the period April 1, 1979 to April 1, 1980.** (Management and Technical Services Co., Philadelphia, PA (USA)). 1980. Contract AC02-78ET13011. 15p. NTIS, PC A02/MF A01.

Management and Technical Services Co./ General Electric was awarded the contract to operate, modify and maintain the DOE/PETC 700 hp, 100 hp, and 20 hp Combustion Test Facility. These facilities were designed and built by the Department of Energy at Pittsburgh Energy Technology Center and its ultimate success is the responsibility of DOE/PETC. MATSCO/GE will provide support to assist in the goal of successful operation of this pilot plant facility. The primary objective of the DOE/PETC 700 hp and 100 hp CTF is to establish the practicality of coal oil slurry combustion as a technically, economically and environmentally feasible retrofit technology. The 20 hp CTF is to provide a test bed to evaluate synthetic fuels for its technical feasibility and its effect on the environment. Four series of combustion tests were completed. Coal-oil mixes for all tests were # 6 fuel oil and Pittsburgh Seam Coal. The tests were executed successfully. Operational problems were handled as required without excessive delay of the testing program. Additional studies performed concurrently with the combustion testing included flame studies, stack emissions studies during all tests, standard measurements of equipment wear after each test

series and extensive erosion and corrosion analyses of boiler test coupons and the burner section of the fuel train after the 500 h endurance test. Testing activity and required facility modifications were coordinated through Department of Energy personnel.

30161 (DOE/FE/2564—T1) **Demonstration program for coal-oil mixture combustion in an electric utility boiler - Category III A. 1978 annual report.** (New England Power Co., Westborough, MA (USA)). Apr 1980. Contract AC01-76ET10380. 150p. NTIS, PC A07/MF A01.

The 1978 annual report covers New England Power Service Company's participation in the Department of Energy coal-oil mixture (COM) program. Continued world-wide unrest resulting in an unstable fuel oil supply coupled with rapidly inflating costs have caused continued interest in a demonstrable viable solution. NEPSCO's program, while not attaining all the milestones forecast, has made considerable progress. As of January 31, 1979, ninety-five (95% percent of engineering and design has been completed. Construction of facilities and installation of required equipment was approximately 75% complete and the six-week Feasibility Testing program was expected to commence during April 1979.

30162 (EPRI-CS—1449(App.1)) **Materials problems in fluidized-bed combustion systems. Appendix 1. Description of tests and plant performance data. Final report.** (National Coal Board, Stoke Orchard (UK). Coal Research Establishment). May 1980. 83p. NTIS, PC A05/MF A01.

Appendix 1 describes the fluidised bed combustion test facility at the National Coal Board, Coal Research Establishment. This facility was used for two 1000 h investigations into the corrosion performance of boiler and gas turbine alloys under the Electric Power Research Institute Contract Ref. 388-1 with Combustion Systems Ltd., UK. Operating procedures, sampling methods and the test conditions are outlined. Detailed mass balances, temperatures, gas, ash, and dust analyses are provided. No conclusions are drawn from the data provided; such conclusions appear in the main report. Appendix 1 does not contain any metallographic data or information on the materials tested; this information appears in Appendix 2.

30163 (EPRI-CS—1449(App.2)) **Materials problems in fluidized-bed combustion systems. Appendix 2. Test specimen preparation, handling, and posttest evaluation. Final report.** Rogers, E.A.; Holder, J.C.; Minchener, A.J.; Page, A.J.; La Nauze, R.D. (National Coal Board, Stoke Orchard (UK). Coal Research Establishment). May 1980. 320p. NTIS, PC A14/MF A01.

Appendix 2 presents the metallographic data compiled by the National Coal Board, Coal Research Establishment, on materials tested for the Electric Power Research Institute Contract R P 388-1 with Combustion Systems Ltd., UK. Two 1000 h tests were carried out to investigate the corrosion performance of boiler and gas turbine alloys exposed in and above a fluidised bed coal combustor. Details are given of the preparation, handling, and examination procedures. Results of metallographic examination and chemical analyses on the samples examined by CRE are provided. This appendix does not attempt to draw any conclusions from the data: such conclusions appear in the main report. Description of the tests and plant performance data are given in Appendix 1 of this report.

30164 (FE—2471-T3) **Industrial application fluidized bed combustion: category III. Indirect fired heaters. Quarterly technical report No. 13, July 1-September 30, 1979.** (Exxon Research and Engineering Co., Florham Park, NJ (USA)). 1979. Contract EX-76-C-01-2471. 23p. NTIS, PC A02/MF A01.

A program is underway to evaluate the technical and economic potential for the application of fluidized bed combustion to refinery and petrochemical plant indirect fired process heaters. A Process Stream Coking Test Unit has been used to study the parameters affecting coke laydown on the internal surfaces of hydrocarbon containing tubes under conditions of high temperature and heat transfer rate. The data analysis shows that in addition to film temperature, mass velocity is an important parameter in controlling coking rate. No coke laydown occurred in any tests run at a mass velocity of 600 lb/sec ft^2 at heat fluxes up to 60,000 Btu/h ft^2. Construction of the High Temperature Heat Flux Test Unit has been completed and testing has begun. The operation of the Heat Flux Unit and the range of data collected is described. The object of the Economic and Applications Task of the Program is to evaluate the economic and logistic factors that might influence the schedule and circumstances under which coal fired Atmospheric Fluidized Bed Combustion (AFBC) technology might be applied to petroleum and petrochemical plant process heaters. The first phase, the Applications Phase, as been completed. The Economic Assessment is now underway. If these assessments plus the technical data obtained in the laboratory R and D phase of the program indicate favorable commercial potential, the program will be advanced to the demonstration phase.

30165 (FE—2689-T3) **Investigation of fuels containing coal-oil-water emulsions fire tube test apparatus design and construction. Seventh quarterly report, April 1-June 30, 1979.** Cherry, N.H.; Stokes, C.S. (Germantown Labs., Inc., Philadelphia, PA (USA)). Jul 1979. Contract EF-77-C-01-2689. 16p. NTIS, PC A02/MF A01.

The design and construction of a fire tube test apparatus for the burning of coal-oil-water emulsions is in progress. The unit is instrumented as to temperatures and flows along with a stack gas analyzer. A detailed description of equipment as well as the results of coal particle size distribution studies is presented.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 30085

30166 (DOE/PE/70090—T1) **Assessment of the candidate markets for liquid boiler fuels.** (Booz, Allen and Hamilton, Inc., Bethesda, MD (USA)). Dec 1979. Contract AC03-79PE70090. 364p. NTIS, PC A16/MF A01.

Liquid fuels can be produced from coal in a number of indirect and direct liquefaction processes. While indirect coal liquefaction has been proved commercially outside the United States, most attention in this country has focused on the direct liquefaction processes, which include the processes under examination in this report; namely, the Exxon Donor Solvent (EDS), the H-Coal, and the Solvent Refined Coal (SRC) II processes. The objectives of the study were to: compare the boiler fuels of direct coal liquefaction with residual fuel oil (No. 6 fuel oil) including physical characteristics and environmental hazards, such as carcinogenic characteristics and toxic hazard characteristics; determine whether a boiler fuel market would exist for the coal liquefaction products given their physical characteristics and potential environmental hazards; determine the advantages of utilizing methanol as a boiler fuel on a continuous basis in commercial boilers utilizing existing technology; identify the potential regional candidate markets for direct coal liquefaction products as liquid boiler fuels; determine the distributing and handling costs associated with marketing coal liquefaction products as liquid boiler fuels; determine the current regulatory issues associated with the marketing of coal liquefaction products as boiler fuels; and determine and evaluate other institutional issues associated with the marketing of direct coal liquefaction products as boiler fuels.

30167 **Coal.** pp 146-209 of Energy in transition 1985-2010. Brooks, H.; Ginzton, E.L. (eds.). San Francisco, CA; W.H. Freeman and Co. (1980).

Coal will remain a key element of US energy policy well beyond the end of this century, regardless of the development of other energy sources. Its prime virtue is availability; it will be used increasingly over the next several decades to make up for delays in the development of other energy sources. In this role, it will help tide the nation over until truly sustainable energy sources can be used to replace dwindling supplies of oil and natural gas. It is likely that demand, rather than supply, will be the limiting factor on coal use for as long as this study looks into the future. In making projections, it is important to distinguish between the near term - up to the late 1980s - and the longer term. First, since the lead time for construction of both coal-fired and nuclear power plants is of the order of 10 years, the electricity-generating capacity of these sources in the near term is already fairly well determined. Second, it is likely that the use of coal will be determined by the availability of facilities that can burn it in an environmentally acceptable manner rather than by the ability to produce or transport coal in sufficient quantities; any shortfalls in electrical output will have to be made up largely from oil- and gas-fired utilities, usually by delaying their phase-out or their transfer from base to intermediate and peak load use. Third, if the expansion of nuclear power is constrained, then demand for coal in the near term will be little influenced by economic considerations or by its competitiveness with nuclear power. For the period beyond 1990 the situation becomes more complex. By then, oil and natural gas will be making smaller contributions to electricity generation, and coal and nuclear fission will tend to be more directly substitutable.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 30143, 31227

PETROLEUM

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 30562

DRILLING AND PRODUCTION

REFER ALSO TO CITATION(S) 30196, 31080

30168 (DOE/BC/20006—17) **Single-well chemical tracer tests since 1968.** Majoros, S.; Deans, H.A. (Rice Univ., Houston, TX (USA)). Jul 1980. Contract AS19-79BC20006. 91p. NTIS, PC A05/MF A01.

The results of 59 single-well chemical tracer tests to measure residual oil saturation, S/sub OR/, are reported. These tests have been run by Exxon Production Research Company and its licensees since 1968 in over thirty reservoirs. The data reported are the test conditions and produced tracer concentration profiles. We have correlated the distribution coefficients and hydrolysis rate constants for the most commonly used tracers to facilitate design of future tests.

30169 (DOE/BETC/5603—10) **Improved polymers for enhanced oil recovery synthesis and rheology. Second annual report, October 1978-September 1979.** McCormick, C.L.; Hester, R.D.; Neidlinger, H.H.; Wildman, G.C. (University of Southern Mississippi, Hattiesburg (USA). Dept. of Polymer Science). Jun 1980. Contract AS05-77ET12038. 253p. NTIS, PC A12/MF A01.

The status of the following studies is given: macromolecular syntheses of model polymers (homopolymer synthesis, random copolymer synthesis, graft-copolymer syntheses); macromolecular characterization by size exclusion chromatography; dilute solution studies (ageing effects on viscosity, shear rate effects on viscosity, structure effects on viscosity, turbidimetric studies); polymer solution rheological studies; macromolecular flow through controlled porous media; and polymer solution flow through simulated porous reservoirs.

30170 (DOE/ET/12056—T1) **Foam as an agent to reduce gravity override effect during gas injection in oil reservoirs. Final report.** Chiang, J.C.; Sanyal, S.K.; Castanier, L.M.; Brigham, W.E.; Shah, D.O. (Stanford Univ., CA (USA). Petroleum Research Inst.). Aug 1980. Contract AC03-76ET12056. 89p. NTIS, PC A05/MF A01.

A two-dimensional, vertical, rectangular plexiglas model holding a 45-1/2 in. high by 11-3/8 in. wide by 1/4 in. thick sandpack (1.147 x 0.237 x 0.008 m) was used to investigate gravity override of injected gases in gas drive processes. Saturation of the sandpack by a surfactant solution instead of pure water sharply increased liquid recovery and breakthrough time in a nitrogen flooding process. The improvement in production was shown to be due to a reduction of gravity override caused by in-situ generation of foam at the gas-liquid interface. Solutions of two different surfactants (Suntech IX and IV) of various concentrations with different amounts of alcohol were studied to determine their effectiveness as foamers. Surface tension and rate of drainage of the foamers as functions of surfactant concentration were measured. In-situ foaming in the model increased generally with surfactant concentration until an optimum concentration was reached; above this concentration, additional amounts of surfactant had very little effect on the phenomenon. Alcohols seem to improve the performance of low molecular weight surfactants and exhibitied a negative effect on the others. A similar increase of recovery and delay in the breakthrough time was observed in the oil flooding process. A slug of surfactant solution was injected into the pack which was saturated with a white mineral oil and water at irreducible water saturation, and then nitrogen was injected. Gravity override was much less than in the cases when no surfactant was present.

30171 (DOE/ET/13067—60) **North Burbank Unit Tertiary Recovery Pilot Test. Final report.** Trantham, J.C. (ed.). (Department of Energy, Bartlesville, OK (USA). Bartlesville Energy Technology Center; Phillips Petroleum Co., Bartlesville, OK (USA)). Jun 1980. Contract AC19-78ET13067. 281p. NTIS, PC A13/MF A01.

During the last fifteen months of the project, fresh water injection was continued, while efforts were made to raise injection rates. Chemical analyses of fluids showed that production of surfactant components and polyacrylamide declined steadily almost to the vanishing point in all the producers. The oil production rate has declined slowly since reaching its peak level of 286 BPD in April 1978, and appears to be on an exponential decline curve which projects the continuation of tertiary oil production several years into the future. As of August 11, 1979 (expiration date), the total oil production rate was about 195 BPD at a water-oil ratio of about 66. At that time, a total of 153,500 barrels of tertiary oil had been recovered. It is predicted that 283,000 barrels of tertiary oil will be recovered if the pilot is operated to the economic limit of the wells. This will require an additional 9 years at present rates of injection.

30172 (DOE/SAN/1188—4) **Williams Holding Lease Steamflood Demonstration Project: Cat Canyon Oil Field. Third progress report, July 1978-November 1979.** Ditmore, T.L. (Getty Oil Co., Ventura, CA (USA)). Jun 1980. Contract AC03-76ET12058. 146p. NTIS, PC A07/MF A01.

This report discusses pilot operations and results during this period. The performance of the displacement steam generator, the status of the sulfur dioxide scrubbing system, well workovers and the results of drilling four thermal observation wells are examined. Additional computer thermal simulation studies are discussed in detail and a new production performance projection is made. Finally, project economics and future operations are summarized.

30173 (DOE/SF/01802—39) **Bell Creek field micellar-polymer pilot demonstration. Third annual report, October 1978-September 1979.** Goldburg, A. (Gary Energy Corp., Englewood, CO (USA)). Jul 1980. Contract AC03-78SF01802. 92p. NTIS, PC A05/MF A01.

Gary Energy Corporation is conducting a DOE Demonstration Pilot to determine if micellar-polymer flooding is an economically feasible technique to enhance oil recovery from the Bell Creek Field, Powder River County, southeastern Montana. The pilot is a contained 40-acre 5-spot located in a representative watered-out portion of Unit A Reservoir. The pay is sandstone with an average net pay of 6.4 feet, air permeability of 1050 md, and water TDS of 4000 ppM. The current average remaining oil saturation in the 40-acre pilot area is estimated to be 28%. The pilot has four injectors (Wells MPP-1, MPP-2, MPP-3, and MPP-4) and one producer (Well 12-1). The overall micellar-polymer oil recovery is estimated at 47% of the remaining oil at the initiation of the micellar-polymer flood. In the third contract year (October 1978 to September 1979), all tasks including the initiation of soluble oil/micellar injection were completed. Test site development included completion of: (1) radioactive tracer survey and analysis, (2) core analysis, (3) pressure pulse tests and analysis, (4) reservoir description, and (5) test site facilities. Based on test site development data, soluble oil/micellar formulation was finalized and mathematical simulation work by Intercomp completed. The preflush injection phase of the demonstration program was completed, and the soluble oil/micellar injection was initiated at the end of the contract year. The pilot demonstration project has progressed as scheduled.

30174 (SAND—80-0483) **FY 80 heavy oil program. First quarterly report, January 1980.** Fox, R.L.; Wayland, J.R. (Sandia National Labs., Albuquerque, NM (USA)). May 1980. Contract AC04-76DP00789. 16p. NTIS, PC A02/MF A01.

Evaluation testing of packers and computational analysis of well bore insulation for heavy oil steam recovery injection wells have been investigated this quarter. An experimental program to measure downhole steam quality is under development. Initial examination of the application of the DOE downhole steam generator program to heavy oil reservoirs has commenced. The examination of alternate extraction concepts of heavy oil has been initiated. An overburden replacement technique was evaluated both computationally and in a laboratory scale experiment. Microwave heating and in situ hydrogenation are being analyzed.

30175 (SAND—80-1223) **Instrumentation and operational requirements for pilot-scale CO_2 enhanced oil recovery projects.** Lyle, W.D. Jr.; Eisenhawer, S.W. (Sandia National Labs., Albuquerque, NM (USA)). Jun 1980. Contract AC04-76DP00789. 51p. NTIS, PC A04/MF A01.

This report describes an instrumentation system to monitor a miscible displacement pilot flood under carefully controlled conditions. The primary focus is on CO_2 flooding but the results apply equally well to other types of miscible floods. Included are discussions of the physical processes in a CO_2 flood, a review of existing CO_2 floods, instrumentation available, site selection and characterization, operation of the flood, simulator evaluation, and cost estimates for this type of project. Throughout the report it is emphasized that determination of residual oil saturation before and after the flood is crucial to evaluation of the results.

30176 (SAND—80-1339) **DEEP STEAM project. Quarterly report, 1 October-31 December 1979.** Eisenhawer, S.W.; Fox, R.L.; Johnson, D.R.; Donaldson, A.B.; Mulac, A.J.; Lyle, W.D.; Clay, R.G. (Sandia National Labs., Albuquerque, NM (USA)). Jul 1980. Contract AC04-76DP00789. 29p. NTIS, PC A03/MF A01.

Objective of Project DEEP STEAM is to develop the technology required to economically produce heavy oil from deep reservoirs. The accomplishments attained during this reporting period include: completion of the initial phase of full-scale simulation testing of thermally efficient well completions, initiation of full-scale simulation testing of two downhole steam generator concepts, and the steam generator and support systems for the Sandia/Chevron field test successfully completed continuous operation evaluation preparatory to delivery to the Bakersfield, CA site.

30177 (SAND—80-1679C) **DOE enhanced oil recovery projects.** (Sandia Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 12p. (CONF-800750—1). NTIS, PC A02/MF A01.

From Meeting for DOE enhanced oil recovery project; San Francisco, CA, USA (22 Jul 1980).

Objectives of Project DEEP STEAM are to examine modified well completions for surface injection into deep reservoirs,

develop economic downhole steam generators, and examine existing reservoir models for modifications required for steam injection into deep heavy-oil reservoirs. The project is designed for producing low-gravity reservoirs.

30178 High vertical conformance steam drive oil recovery method. Brown, A.; Reynolds, B.L.; Hall, W.L. (to Texaco Inc.). US Patent 4,177,752. 11 Dec 1979. Filed date 24 Aug 1978. 10p.

The vertical conformance of a steam drive process is improved and steam override reduced by penetrating the zone between one injector and one producer well with an infill well which is in fluid communication with the bottom half of the formation. Petroleum is produced from the infill well after steam channeling has occurred at the production well. After the water cut of the fluids being produced from the infill well reaches 95%, the infill well is converted from a producer to an injector, and hot water is injected into the lower portion of the formation via the infill well. Fluids are then produced from the production well. By this means, oil is recovered from the lower portions of the formation adjacent to the production well. After water breakthrough occurs at the production well, steam is injected into the infill well and fluids are recovered from the production well. By this multi-step process involving the infill well, the amount of oil recovered from the portion of the formation in the recovery zone defined by the injection and production well is increased significantly.

30179 Drilling rig heater. Finch, C.E. Jr. US Patent 4,177,792. 11 Dec 1979. Filed date 20 Mar 1978. 6p.

A heater includes a first housing which forms a fuel reservoir and a base support to maintain the heater in an upright position. A first elongated hollow or tubular member is secured to the top of the first housing with its lower end communicating with the interior of the first housing and extends upwardly therefrom. A second housing is mounted on top of the first housing and is provided with opening or port means to communicate the top of the first housing with the second housing. Port means in the second housing also communicates the second housing with the first elongated tubular member. A second elongated, hollow or tubular member is mounted on the second housing and extends upwardly therefrom. Its lower end communicates with the top of the second housing for communicating air to the second housing. Valve means are provided in each the first and second elongated hollow members for selectively controlling communication therethrough.

PROCESSING

REFER ALSO TO CITATION(S) 30057, 30164

30180 (DOE/SF/10760—2) **Hydroprocessing of heavy oils. Quarterly technical progress report, December 4, 1979-March 3, 1980.** Bowman, R.M.; Jody, B.J.; Jarvi, G. (Institute of Gas Technology, Chicago, IL (USA)). Jun 1980. Contract AC03-79SF10760. 23p. NTIS, PC A02/MF A01.

During the second quarter of the Contract, Task 1 experimentation to hydrodesulfurize (HDS) and hydrocrack (HC) No. 4 fuel oil continued. Two of the three available catalysts (Shell 324 and a proprietary Union Carbide catalyst) were evaluated. Shell 324 could remove as much as 96% of the sulfur originally in the oil and convert up to 41% of the nonreformable fraction in the oil to reformable products at 500°C. Operating at this high temperature, however, resulted in the deposit of black carbon-containing material on the catalyst pellets, thereby restricting the flow across the reactor. The Union Carbide catalyst was tested at temperatures up to 470°C. The product oil was found to represent 95% sulfur removal and 48% conversion to reformable products. Black carbon-based deposits were detected on the catalyst. Because the conditions under which these tests were carried out were not optimized, it may be possible to improve the quality of the products. Also, recycling the nonreformable material back into the reactor for further cracking will be investigated.

30181 Simultaneous ir/kinetic study of supported platinum methanation catalysts. Vannice, M.A.; Moon, S.H.; Twu, C.C. (Pennsylvania State Univ., University Park). *Am. Chem. Soc., Div. Pet. Chem., Prepr.;* **25**: No. 2, 303-311(Mar 1980). (CONF-800303—(Vol.25No.2)).

From 179. national meeting of the American Chemical Society; Houston, TX, USA (23 Mar 1980).

The initial results are presented of a study to see if the support or the metal crystallite size has a significant effect on the state of adsorbed CO and, if it does, whether the different forms of adsorbed CO can be correlated with changes in catalytic properties.

30182 EXAFS studies of supported metal catalysts. Via, G.H. (Exxon Research and Engineering Co., Linden, NJ); Sinfelt, J.H.; Lytle, F.W. *Am. Chem. Soc., Div. Pet. Chem., Prepr.;* **25**: No. 2, 313-315(Mar 1980). (CONF-800303—(Vol.25No.2)).

From 179. national meeting of the American Chemical Society; Houston, TX, USA (23 Mar 1980).

Extended x-ray absorption fine structure (EXAFS) was used to study the average structure of metal clusters in a number of highly dispersed monometallic catalysts. Clusters of osmium, iridium, and platinum dispersed on silica or alumina were investigated. The metal clusters in the catalysts constituted 1.0 wt % of the total mass, and measurements were made following thorough reduction of the catalysts at elevated temperature. The EXAFS data on the metal clusters and were compared to data on the metal clusters were compared to data on the corresponding bulk metals in the analysis. The general conclusions of this work are: (1) first neighbor bond distances in the metal clusters differed from these in the bulk metals by <0.02 A. (2) First neighbor coordination numbers for the metal clusters ranged between 7 and 10 as compared to 12 for the bulk metals. These low coordination numbers are consistent with the high state of dispersion for the catalysts. (3) The thermal or static disorder, σ_1, for atoms in the metal clusters was found to be larger by a factor of 1.4 to 2 rather than σ_1 for the bulk metals, which reflects the high percentage of surface atoms in the metal clusters.

30183 Sulfur poisoning of H_2 and CO adsorption on supported nickel. Bartholomew, C.H.; Pannell, R.B. (Brigham Young Univ., Provo, UT). Contract EX-76-S-01-1790; EF-77-S-01-2729. *Am. Chem. Soc., Div. Pet. Chem., Prepr.;* **25**: No. 2, 319-323(Mar 1980). (CONF-800303—(Vol.25No.2)).

From 179. national meeting of the American Chemical Society; Houston, TX, USA (23 Mar 1980).

Effects of H_2S on adsorption of H_2 and CO on unsupported nickel are: H_2 adsorption at 298°K and CO adsorption at 190°K were lowered by presulfiding; and irreversible CO adsorption at 298°K was decreased, whereas reversible adsorption was increased after presulfiding, the stoichiometry in the latter case suggesting the formation of $Ni(CO)_4$. Recent studies indicate a similar, but even more complex behavior in the case of supported nickel. These effects of sulfur poisoning on H_2 and CO adsorption on supported nickel are described and discussed.

30184 Novel methods for metal and heteratom removal. Surface studies related to petroleum chemistry. Homogeneous catalysis. Catalytic reactions involving synthesis gas. Coal liquids upgrading. Rescorla, A.R. (ed.). Washington, DC; American Chemical Society (1980). 196p. (CONF-800303—(Vol.25No.2)). Phillips Petroleum Co., Bartlesville, OK 74004.

From 179. national meeting of the American Chemical Society; Houston, TX, USA (23 Mar 1980).

Selected papers were abstracted for inclusion in the Energy Data Base.

30185 Supported catalyst for demetalation and desulfurization of hydrocarbon oils. Oleck, S.M.; Sherry, H.S. (to Mobil Oil Corp.). US Patent 4,177,163. 4 Dec 1979. Filed date 8 Mar 1978. 10p.

Novel catalyst support, catalyst and process for hydrodemetalizing sulfur and metal-contaminated hydrocarbon oils such as residual petroleum fractions or whole crudes are described. The process may be used to prepare feedstocks suitable for fluid catalytic cracking. The novel catalyst support is alumina modified with rare earth oxide. 2 figures, 3 tables.

30186 Aromatics extraction process. Kruse, L.W. (to Standard Oil Co.). US Patent 4,177,137. 4 Dec 1979. Filed date 7 Nov 1977. 4p.

Substantial energy savings are realized in an aromatic extraction process wherein a vapor sidestream is removed from the solvent stripper, compressed and used to provide the heat necessary for distillation in the solvent stripper. 2 figures.

PRODUCTS AND BY-PRODUCTS

30187 Process for producing high-crystalline petroleum coke. Hayashi, K.; Nakaniwa, M.; Kobayashi, N.; Yamamoto, M.; Hase, Y. US Patent 4,177,133. 4 Dec 1979. Priority date 25 Sep 1974, Japan, 16p.

A high-crystalline petroleum coke is produced from low-sulfur petroleum feedstock such as virgin crude oil, distillation residuum and cracked residuum by subjecting the feedstock to preheat treatment under specific conditions to effect cracking and soaking thereof, subjecting the preheat-treated feedstock to flash distillation to remove non-crystalline substances contained therein as pitch and to recover distillate, fractionating the distillate to provide a heavy residue and subjecting the heavy residue to a delayed coking under specific conditions to produce the desired coke which has a coefficient of thermal expansion of less than 1.0×10^{-6}/°C over 100 to 400°C. (1 figure, 3 tables.

30188 Process for the continuous production of petroleum-derived pitch. Uemura, S.; Yamamoto, S.; Hirose, T.; Takashima, H.;

Kato, O.; Nagi, M. (to Nippon Oil Company, Ltd.). US Patent 4,177,132. 4 Dec 1979. Priority date 12 Nov 1976, Japan, 14p.

A process for the continuous production of petroleum-derived pitch comprises the steps of subjecting a heavy fraction boiling at not lower than 150°C, the heavy fraction being obtained by the steam cracking of petroleum-derived hydrocarbons, to a specified first-step treated fraction to a specified second-step heat treatment and then removing the light fraction from the second-step treated fraction thereby to obtain the petroleum-derived pitch. 5 figures, 6 tables.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 30771

30189 (DOE/PE—0019(Vol.2)) **State of competition in gasoline marketing. Part I. Effects of refiner operations at retail (a study required by Title III of the Petroleum Marketing Practices Act). Volume II. Appendix C, complete Fort Wayne hearing transcript.** Delaney, J.B.; Fenili, R.N. (Department of Energy, Washington, DC (USA). Assistant Secretary for Policy and Evaluation). May 1980. 358p. NTIS, PC A16/MF A01.

This Appendix contains the entire record of the regional hearing conducted in Fort Wayne, Indiana on August 21, 1979. In addition to the transcript of the proceedings (section I), written statements submitted at the hearing are reproduced in section II, beginning at page 108. Written responses to questions and comments received by the Office of Competition after the date of the hearing are included in section III, beginning at page 303 of this Appendix.

30190 (DOE/PE—0019(Vol.3)) **State of competition in gasoline marketing. Part I. Effects of refiner operations at retail (a study required by Title III of the Petroleum Marketing Practices Act). Volume III. Appendix D, excerpts from Title III hearings, and Appendix E, data collection forms and subpoena specifications.** Delaney, J.B.; Fenili, R.N. (Department of Energy, Washington, DC (USA). Assistant Secretary for Policy and Evaluation). May 1980. 157p. NTIS, PC A08/MF A01.

The first section of this digest deals with the documentation of alleged subsidization by refiners and wholesalers presented at the regional hearings. A series of attachments contains the quantitative data, as well as responses from companies accused of subsidization. The second section focuses on the costs of marketing gasoline. A significant element in any discussion of subsidization is the relationship between selling price, operating costs, and the volume of gasoline sold. Are integrated marketers using profits from one segment of their operations to offset losses incurred at the retail marketing level as a result of selling below cost. As the testimony reveals, there is a wide range in the perceived marketing costs by different types of marketers. The third section relates to the impacts of DOE regulations on the behavior of different gasoline marketers. Much of the testimony at the regional hearings dealt with competitive problems, including instances of government induced subsidization, created by DOE's price and allocation regulations. The final section compiles the proposed remedies suggested by various witnesses at the hearings. These proposals included: A. divorcement or divestiture of refiner and wholesaler operated retail outlets, B. decontrol of motor gasoline, C. functional accounting for retail marketing operations, and D. the establishment of rack pricing for all gasoline marketers. We believe that the following distillation of the testimony presented at the regional hearings on Title III of the Petroleum Marketing Practices Act is indicative of the perceived competitive problems confronted by various gasoline retailers, wholesalers, and refiners in today's marketplace.

30191 (DOE/S—0011) **Final report to the President on oil supply shortages during 1979.** (Department of Energy, Washington, DC (USA)). Jul 1980. 62p. NTIS, PC A04/MF A01.

Stockpile levels at the beginning of 1979, imports during the first half of the year, and inventory management were primarily responsible for the oil supply shortage in the spring and summer of 1979. There was a 3.1% reduction in oil supply in May to July of 1979 relative to the same period in 1978, and a 0.2% reduction relative to 1977. The reduction in available oil between 1979 and previous years was even greater than the reduction in supply. Domestic production of crude oil declined between May to July of 1978 and the same period in 1979. This was consistent with the long-term trend. Free-world oil production dropped by about 2 million b/d during the first quarter of 1979 as a result of the loss of Iranian production. Production returned to pre-disruption levels by the middle of 1979. The US share of free-world oil supply dropped by 2% in the second quarter of 1979 compared to the 1977-78 average. Gasoline supplied to consumers during May to July 1979 was 8.5% less than in the same period in 1978, and 7 to 9% less than the amount that would have been consumed if there had been no supply restriction. Compared to 1978, reduced gasoline production during this period in 1979 accounted for 36% of the supply reduction, and reduced use of stocks accounted for 64% of the supply reduction. Refiners could have made more gasoline available during May to July of 1979 without reducing stocks below minimum operating levels. The yield of gasoline relative to other petroleum products went down in May to July of 1979 as compared to the same period in 1977 and 1978. Most of the increase was in production of petrochemical feedstocks. Refiners who were bound by DOE price controls or who were complying with CWPS guidelines could not have increased allowable revenues by delaying the sale of gasoline. Virtually all of the gasoline price increases that took place between January and August 1979 were based on cost increases.

30192 (EMD—80-70) **Effects in Washington, DC, area of 1979 gasoline shortage: supplies less than national average; price increases comparable.** (General Accounting Office, Washington, DC (USA)). 24 Jun 1980. 60p. General Accounting Office, Washington, DC.

During May and June 1979 the Washington, DC, metropolitan area received, respectively, 6 and 10% less gasoline than the national average. Although the price of gasoline in the Washington, DC, area increased significantly during the first 7 months of 1979, it was comparable with the national average. The Department of Energy has not developed overall criteria and guidelines to determine when an area has a gasoline supply imbalance which requires the shifting of supplies from other areas. Also, the Department does not know whether the gasoline tilt rule - which gives refiners increased flexibility to allocate additional costs to gasoline - is accomplishing its objectives. The Department, therefore, should develop the necessary criteria and guidelines for responding to gasoline supply imbalances and should determine exactly how the gasoline tilt rule has been working and whether revisions are needed.

30193 (LPR—21(P-23A-1)) **Discriminant analysis approach for predicting oil/gas production of Federal offshore leases.** Berger, P.D.; Lohrenz, J. (Geological Survey, Denver, CO (USA). Conservation Div.). Jun 1980. 12p. Geological Survey, P.O. Box 25046, Federal Center Bldg. 85, Denver, CO 80225.

A set of 839 leases comprising the entire set of Federal offshore oil and gas leases issued in 1954 through 1962 were investigated. Using linear discriminant analysis, the question of how well one could predict whether a lease becomes productive was addressed, based only on variables consisting of (1) the bidding pattern for the lease, and (2) simple physical properties of the lease without precise geophysical or geological information content. The prediction is superior to random classification of leases, and indeed superior to the judgment of the decision-makers who decided, presumably using all geophysical and geological information at access to them, which leases to drill.

30194 (LPR-P—11/15B) **Effect of aggressive and conservative bias in Federal offshore oil and gas lease bonus bidding.** Dougherty, E.L.; Lohrenz, J. (Geological Survey, Denver, CO (USA). Conservation Div.). Jun 1980. 37p. Geological Survey, P.O. Box 25046, Federal Center Bldg. 85, Denver, CO 80225.

Assuming bids are lognormally distributed, a measure of the degree of aggressive or conservative bias is derived relative to his competitors which an individual bidder displays in bidding for Federal offshore oil and gas leases, and how (a) the expected frequency of submitting the highest bid for a lease, (b) the expected ratio of the highest bid to the geometric mean of bids, and (c) the expected fraction of money left on the table, vary with the bias and the number of bids per lease are quantified. Results achieved with biased bids for Federal offshore oil and gas leases agree with the statistical predictions just as the winnings and losings of lucky and unlucky gamblers collectively follow the inherent odds of any game they are playing. The findings can be used by individual bidders to make a priori predictions of results from aggressive or conservative bidding. Or, after bidding, the results can be used to make assessments of how a bidder (or estimator) fared compared to the inherent odds due to luck and acumen, or their opposites.

WASTE MANAGEMENT

30195 (DOE/BC/10008—9) **Engineering design of a solvent treatment/distillation used lubricating oil re-refinery.** Brinkman, D.W. (Stubbs Overbeck and Associates, Inc., Houston, TX (USA)). Jun 1980. Contract AC19-79BC10008. 74p. NTIS, PC A04/MF A01.

Drawings and specifications were prepared for a 10 million gallon per year used lubricating oil re-refinery based on the solvent treatment/distillation process developed and patented by the Bartlesville DOE Energy Technology Center. In addition, flowsheets were developed for facilities to treat 2, 5, and 20 million gallons per year. Using these drawings and specifications, a detailed capital cost estimate was prepared for the 10 million gallon facilities. Prorated estimates were derived for the other three capacities.

30196 (DOE/ET/12088—1) **Evaluation of flue gas desulfurization processes for application to California oil fields.** Patkar, A.N.; Kothari, S.P.; Tuttle, J.D. (PEDCO-Environmental, Inc., Cincinnati, OH (USA)). Apr 1980. Contract ET-78-C-01-3059. 349p. NTIS, PC A15/MF A01.

This report evaluates the applicability of 12 flue gas desulfurization (FGD) processes to thermally enhanced oil recovery operations in California. Purpose is to provide information that will help the oil companies plan FGD strategies and the US DOE plan research and development projects. After reviewing current sulfur dioxide emission limitations and existing FGD systems in the California oil fields, the report discusses the design basis, equipment sizing methodology, and cost basis used in the evaluation. Intermediate-level process designs and detailed cost estimates are given for the most promising processes, and others receive some attention. The report then compares cost estimates, describes byproduct marketability, offers process selection criteria, presents bid preparation and evaluation guidelines, and makes R and D recommendations.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 30140, 31161, 31230

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 30189, 30190, 30770

30197 **Outer Continental Shelf statistics: oil, gas, sulphur, salt, leasing, drilling, production, income. 1953-calendar year 1979.** Harris, W.M.; McFarlane, B.E.; Williams, M.A.; Hammersley, R. (comps.). Reston, VA; Geological Survey (1980). 97p. (NP—24974).

The Conservation Division of the Geological Survey collects royalties, supervises operations and production of minerals under lease on Federal, Indian, and Outer Continental Shelf lands. This publication is primarily a compilation of statistics pertaining to the leases, production, and royalties.

PROPERTIES

REFER ALSO TO CITATION(S) 31010

30198 (DOE/BC/10171—1) **Analysis of heavy ends from petroleum by probe microdistillation/mass spectrometry. Quarterly report, December 15, 1970-March 14, 1980.** Grigsby, R.D.; Schronk, L.R. (Texas A and M Univ., College Station (USA). Dept. of Biochemistry and Biophysics). 20 May 1980. Contract AC19-80BC10171. 97p. NTIS, PC A05/MF A01.

Seven samples from a 535 to 675°C distillate of a Wilmington, CA crude oil were received from the Instrumental Section of the Bartleville Energy Technology Center. These samples were obtained from extensive fractionation of the original crude through the technique developed for the American Petroleum Institute Research Project 60 (API 60). The samples were subjected to probe microdistillation with the temperature programmed to maintain a constant ion current. Between 5 and 22 spectra were recorded for each. Three spectra per sample were processed into graphic and tabulated form to display the molecular weight distribution as a function of distillation temperature. A number of elemental compositions were obtained by high-resolution mass spectroscopy for sample GPC 209-76, fraction 22. This permitted partial assignment of Z numbers to components.

COMBUSTION

REFER ALSO TO CITATION(S) 30160, 30161, 30165, 30601

NATURAL GAS

DRILLING, PRODUCTION, AND PROCESSING

REFER ALSO TO CITATION(S) 31080

HEALTH AND SAFETY

30199 (DOE/EV/06020—T1) **Fire safety of LPG in marine transportation. Final report.** Martinsen, W.E.; Johnson, D.W.; Welker, J.R. (Applied Technology Corp., Norman, OK (USA)). Jun 1980. Contract AC05-78EV06020. 215p. NTIS, PC A10/MF A01.

This report contains an analytical examination of cargo spill and fire hazard potential associated with the marine handling of liquefied petroleum gas (LPG) as cargo. Principal emphasis was on cargo transfer operations for ships unloading at receiving terminals, and barges loading or unloading at a terminal. Major safety systems, including emergency shutdown systems, hazard detection systems, and fire extinguishment and control systems were included in the analysis. Spill probabilities were obtained from fault tree analyses utilizing composite LPG tank ship and barge designs. Failure rates for hardware in the analyses were generally taken from historical data on similar generic classes of hardware, there being very little historical data on the specific items involved. Potential consequences of cargo spills of various sizes are discussed and compared to actual LPG vapor cloud incidents. The usefulness of hazard mitigation systems (particularly dry chemical fire extinguishers and water spray systems) in controlling the hazards posed by LPG spills and spill fires is also discussed. The analysis estimates the probability of fatality for a terminal operator is about 10^{-6} to 10^{-5} per cargo transfer operation. The probability of fatality for the general public is substantially less.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 30193, 30194, 30771

30200 (DOE/EIA—0176(80)) **Buyer/Seller Codes: authorized for reporting to the Federal Energy Regulatory Commission.** Ryan, J. Sr.; Hirsh, M. (Department of Energy, Washington, DC (USA). Energy Information Administration). Jul 1980. 151p. NTIS, PC A08/MF A01.

The Buyer/Seller Codes in this publication are six digit code numbers assigned to buyers and sellers of natural gas for use in Federal Energy Regulatory Commission (FERC) data collection efforts. The publication is organized alphabetically by name. Names of individual persons are listed in alphabetical order, last name first. Company names are listed in alphabetical order, exactly as the legal company name is written, within the constraints of a 35 character line. When contractions or abbreviations were necessary to fit within 35 characters, such changes were made. In instances where an agent has previously made filings with FERC on behalf of one or more principals, the agent and the various principals have each been assigned unique six digit code numbers. In instances where a filing has previously been made by an individual person doing business under another name (Joe Smith d/b/a Smith and Company) both names have been assigned unique code numbers and are listed separately in alphabetical order. The Division of NGPA Compliance, Office of Pipeline and producer Regulation, Federal Energy Regulatory Commission, Washington, DC 20426, should be notified, in writing, of any corrections that should be made to the information contained in this publication, which will be updated as required.

30201 (DOE/RG—0035/1) **Public Utility Regulatory Policies Act of 1978: Natural Gas Rate Design Study.** (Department of Energy, Washington, DC (USA). Economic Regulatory Administration). May 1980. 84p. NTIS, PC A05/MF A01.

The report concludes that, to effectively deal with our national energy problems, gas rate structures should be designed to reflect the costs which the nation avoids if gas is efficiently used and substituted for oil. Current pipeline and distribution company rate structures generally do not meet this test. Although gas is a substitute for oil in many applications, and conserved gas can reduce oil imports, gas rate structures often fail to convey to consumers the fact that, from a national perspective, gas is as valuable as oil. The provisions of the Natural Gas Policy Act of 1978 (NGPA) take a strong first step in correcting these problems. But, as clearly recognized in both NGPA and PURPA, these provisions need to be supplemented by updating pipeline and distribution company rate designs to address the problems of the 1980's - rather than the problems of the 1950's. In this regard, NGPA mandates incremental pricing, which raises the average price of gas to certain industrial users only. The Department of Energy (DOE) study suggests an alternate approach: pipeline and distribution rate structures that reflect in their tailblocks, for all customer classes, the economic costs of gas usage. Such rates would convey to all users the costs incurred by the nation as a consequence of their decisions to use or conserve gas. Such rate structures should promote the three purposes of PURPA - end-use conservation, efficient use of utility resources, and equitable rates - to a greater extent than do traditional accounting cost rate designs, which reflect decisions made in the distant past.

ENVIRONMENTAL EFFECTS

REFER ALSO TO CITATION(S) 31161

30202 (UCID—18745) **Microcomputer firmware description, LGF data acquisition system.** Baker, J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 26 Jun 1980. Contract W-7405-ENG-48. 19p. NTIS, PC A02/MF A01.

The firmware developed at LLL for the LLL Data Acquisition System for Liquefied Gaseous Fuels Program is described. Approximately 4000 lines of assembly language coding were developed; structured-macros and top-down structured programing design techniques were used. This coding executes from read-only-memory in 51 Complementary-Metal-Oxide Semiconductor (CMOS) battery-powered data acquisition systems. The systems are being deployed at NWC, China Lake for acquiring data during liquefied natural gas dispersion tests. 1 figure, 5 tables.

ARTIFICIAL STIMULATION, PLOWSHARE, ETC.

30203 (DOE/BC/10003—9) **Western gas sands project. Status report, 1 April-30 April, 1980.** (CER Corp., Las Vegas, NV (USA)). 1980. Contract AC08-79BC10003. 62p. NTIS, PC A04/MF A01.

The progress of the government-sponsored projects directed towards increasing gas production from the low permeability gas sands of the western United States is summarized. Planning activities continued for the multi-well experiment. Bartlesville Energy Technology Center continued formation evaluation studies for the WGSP. Theoretical analyses continued at Lawrence Livermore Laboratory for fracture growth across frictional interfaces and fluid flow in a fracture. Studies have begun at Los Alamos Scientific Laboratory on NMR signals coming from fluids in porous media. Analyses continued of information gathered from Sandia's fracture experiment in Grayson County, Texas. Tests using the DOE Well Test Facility were completed for the Colorado Interstate Gas Company cyclic dry gas injection experiment. At the NTS, Sandia is conducting minifractures.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 30197, 30200, 30770, 30772

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 30199, 30355

OIL SHALES AND TAR SANDS

RESERVES AND EXPLORATION

30204 (DOE/METC/12594—12) **Eastern gas shales bibliography selected annotations: gas, oil, uranium, etc. Citations in bituminous shales worldwide.** Hall, V.S. (comp.). (Kentucky Univ., Lexington (USA)). Jun 1980. Contract AP21-79MC12594. 540p. NTIS, PC A23/MF A01.

This bibliography contains 2702 citations, most of which are annotated. They are arranged by author in numerical order with a geographical index following the listing. The work is international in scope and covers the early geological literature, continuing through 1979 with a few 1980 citations in Addendum II. Addendum I contains a listing of the reports, well logs and symposiums of the Unconventional Gas Recovery Program (UGR) through August 1979. There is an author-subject index for these publications following the listing. The second part of Addendum I is a listing of the UGR maps which also has a subject-author index following the map listing. Addendum II includes several important new titles on the Devonian shale as well as a few older citations which were not found until after the bibliography had been numbered and essentially completed. A geographic index for these citations follows this listing.

SITE GEOLOGY AND HYDROLOGY

REFER ALSO TO CITATION(S) 30204

SITE GEOLOGY

30205 (METC/EGSP—302) **Net thickness of the radioactive shale facies in the upper Olentangy Shale.** Honeycutt, M.; Majchszak, F.L. (Ohio Dept. of Natural Resources, Columbus (USA). Div. of Geological Survey). 1980. Contract AS05-76ET12131. 100p. NTIS, PC A05/MF A01.

This map represents the net thickness of the radioactive shale facies included in that part of the Olentangy Shale of Ohio which correlates to the West Falls, Sonyea, and Genesee Formations of New York State. Specifically excluded from consideration is the uppermost part of the upper Olentangy Shale which correlates to the Java Formation of New York. The net thickness of radioactive shale is determined by first establishing a normal base line for each well based upon the gamma ray log response of shale units, such as the Bedford, Chagrin, and certain units within the Olentangy, observed to be fairly consistently radioactive. Radioactive shales are then defined as those shales having a gamma ray response 20 API units or more to the right of the shale base line. The combined thickness of beds reaching the radioactive shale threshold value is reported as the net thickness of radioactive shale facies within the mapping unit.

30206 (USGS-OFR—80-707) **Defining organic-rich facies in the Devonian shale in the western part of the Appalachian basin.** Schmoker, J.W. (Geological Survey, Washington, DC (USA)). 1980. 13p. Dept. of the Interior, Washington, DC.

The Devonian shale section is often divided into organic-rich (black) and organic-poor (gray) subdivisions. In some instances, coarser grained gray shale may act as a reservoir and produce gas, but in the western part of the Appalachian basin the organic-rich shale facies are believed to contain the bulk of the producible gas resource. Therefore, Devonian-shale studies usually emphasize the organic-rich facies. If drill cuttings are available for the Devonian shale sequence, the boundary between organic-rich and organic-poor facies is commonly based on the color of the shale. Other boundary definitions are based on gamma-ray wireline logs, with the assumption that natural gamma radiation and organic content correlate. A gamma-ray intensity of 20 API units above the gray-shale baseline has been used to define the boundary between organic-rich and organic-poor facies (20-API method); a gamma-ray intensity of 230 API units has been used as the threshold value for shale of high gas content and could thus be regarded as another definition of the organic-rich, organic-poor boundary (230-API method). An organic-matter content of 2% by volume (0.8% by weight) is favored by the author as the best definition of the organic-rich, organic-poor boundary (2% method).

DRILLING, FRACTURING, AND MINING

30207 (FE—2468-42) **Oil Mining. Final report, Task 014.** Reed, W.F. Jr. (Engineering Societies Commission on Energy, Inc., Washington, DC (USA)). Jun 1979. Contract EF-77-C-01-2468-014. 48p. NTIS, PC A03/MF A01.

This ESCOE task report covers the production of oil by open pit mining of oil sand deposits in the United States and surface extraction of the oil. A companion area is application of the same technology to shallow oil fields in lieu of other means of enhanced oil recovery. The report surveys possible mineable domestic sites and suggests candidates for developmental projects. Possible extraction techniques including those used in Canada, solvent extraction and retorting are discussed. It is pointed out that separation of fines and recovery of solvent are the two major extraction problems.

30208 (SAND—80-0836) **Rock Springs Site 12 hydraulic/explosive true in situ oil shale fracturing experiment.** Parrish, R.L.; Boade, R.R.; Stevens, A.L.; Long, A. Jr.; Turner, T.F. (Sandia National Labs., Albuquerque, NM (USA)). Jun 1980. Contract AC04-76DP00789. 87p. NTIS, PC A05/MF A01.

The experiment plan involved the creation and characterization of three horizontal hydraulic fractures, followed by the insertion and simultaneous detonation of slurry explosive in the two lower fractures. Core analyses, wellbore logging, and airflow and ^{85}Kr tracer tests were used for site characterization and assessment of the hydraulic and explosive fracturing. Tiltmeters, wellhead pressure and flow gages, and in-formation pressure, flow and crack-opening sensors were used to monitor hydrofracture creation and explosive insertion. Explosive detonation diagnostic data were taken with stress and time-of-arrival gages and surface and in-formation accelerometers. The post-fracturing assessments indicated that: (1) hydrofracture creation and explosive insertion and detonation were accomplished essentially as planned; (2) induced fractures were randomly distributed through the shale with no extensively fractured regions or dislocation of shale; and (3) enhancement of permeability was limited to enlargement of the explosive-filled fractures.

30209 (SAND—80-1344C) **Enhancing permeability in oil shale and applications to tar sands.** Schamaun, J.T. (Sandia Labs., Albu-

querque, NM (USA)). 1980. Contract AC04-76DP00789. 13p. (CONF-800541—3). NTIS, PC A02/MF A01.

From Tar sands permeability enhancement workshop; Albuquerque, NM, USA (8 May 1980).

Explosive fracturing and rubblization are used to enhance oil shale permeability. Blasting strategy and results are discussed, in particular the Geokinetics blasting. The field data desired are listed. Comments are offered on the extension of the blasting techniques to tar sands. (DLC)

OIL PRODUCTION, RECOVERY, AND REFINING

IN SITU METHODS, TRUE AND MODIFIED

30210 (FE—1747-T1) **BX in situ oil shale project. Site evaluation report.** (Equity Oil Co., Salt Lake City, UT (USA)). 11 Nov 1977. Contract ET-78-F-03-1747. 155p. NTIS, PC A08/MF A01.

The Site Evaluation of the BX In Situ Oil Shale Project was conducted to determine if the selected project site was suitable for the conduct of the proposed project. Site evaluation work included the drilling, coring, and logging of two core holes and the analysis of the cores therefrom; temperature logging of existing wells at the project site; and the performance and analysis of pulse tests to evaluate inter-well communication. The site evaluation confirmed that the site would be suitable for the proposed project.

30211 (FE—2346-72) **Energy from in situ processing of antrim oil shale. Quarterly technical progress report, April-June 1980.** Young, D.C. (Dow Chemical Co., Midland, MI (USA)). Jul 1980. Contract AC01-76ET121153. 24p. (DOW/SRPR—72). NTIS, PC A02/MF A01.

Processing of data from the F80 extraction trials continued for much of this quarter. Several computer programs were written so the data could be evaluated or accessed for plotting. Numerous computer generated plots were made for use in the topical reports which are in preparation. Activity at the experimental site has been directed toward an orderly shutdown and dismantling of equipment. All but nine of the wells were filled with cement and capped in accordance with th requirements of the Michigan Department of Natural Resources. Shale characterization work was continued at four universities in Michigan under subcontracts. Work on final reports of several of these projects has begun.

30212 (SAND—80-0824) **Oil shale programs. Sixteenth quarterly report, October-December 1979.** Stevens, A.L. (ed.). (Sandia National Labs., Albuquerque, NM (USA)). Jun 1980. Contract AC04-76DP00789. 35p. NTIS, PC A03/MF A01.

This document is the sixteenth in a continuing series of quarterly reports, and describes the Sandia National Laboratories oil shale activities during the period between October 1, 1979 and December 31, 1979. Sandia's major responsibility to the DOE in situ oil shale program is to provide a quantitative evaluation to DOE of the various field projects being supported by DOE in the development of commercial in situ oil shale processes. This requires the deployment of instrumentation systems and analysis techniques to evaluate key procedures and operations. In order to fulfill this responsibility, it is necessary to develop new and advanced instrumentation systems and associated deployment, recording and analysis techniques that are unique to the field projects. In addition, a rock mechanics program provides material properties, material response models, and computational methods to support the design and evaluation functions. This report describes detailed activities in these project areas over the last quarter.

30213 (SAND—80-1127) **Stress wave propagationin the site 12 hydraulic/explosive fracturing experiment.** Boade, R.R.; Reed, R.P. (Sandia National Labs., Albuquerque, NM (USA)). May 1980. Contract AC04-76DP00789. 45p. NTIS, PC A03/MF A01.

The Site 12 experiment was a heavily instrumented field event performed to examine the hydraulic/explosive fracturing concept for preparing an underground oil shale bed for true in situ processing. One of the key phases of this fracturing concept is the blasting operation which involves the insertion and detonation of slurry explosive in a pre-formed system of hydrofractures. To obtain a sound understanding of the nature of the blasting operations, a rather extensive array of stress gages, accelerometers, and time-of-arrival gages was installed in the rock mass in the vacinity of the explosive to monitor the dynamic events initiated by the detonation. These gages provided considerable amounts of information which were useful in evaluating overall results of the experiment. Details of the gage array, of the data, of analysis methods, and of the results and conclusions are considered in the report.

30214 (SAND—80-1455) **Minimum bed parameters for in situ processing of oil shale. Second quarterly report, January 1-March 31, 1980.** Tyner, C.E. (Sandia National Labs., Albuquerque, NM (USA)). Jun 1980. Contract AC04-76DP00789. 20p. NTIS, PC A02/MF A01.

This is the second in a series of quarterly reports on the Minimum Bed Parameters for In Situ Processing of Oil Shale Program (FE Control No. 4-79 ET 14165.000). It describes activities during the period January 1 to March 31, 1980, including modification of the laboratory retorting system to eliminate problems with the ignition and product collecttion systems and the successful retorting of a 16% void sample. The sample consisted of a 7.6 cm diameter by 23 cm competent core of oil shale with three 0.64 cm slices of material removed parallel to the axis of the cylinder. The 1.4 cm thick slabs constituted 70% of the sample volume, while oil shale rubble (-.32 + .16 cm) was used to occupy nearly half the remaining volume (14%), leaving 16% void. The sample was instrumented, sealed in an insulated retort vessel, ignited with hot (700°C) air, and combustion-retorted with air. The observed retorting rate was 10 cm/hr, the local heating rate near the block surface in the retorting zone was 18°C/min, and peak temperatures were about 825°C. Temperature profiles across the retort cross-section indicated some limited heat loss. Oil yield was 92% of Fischer Assay. Results of block retort model calculations (without rubble in the fracture) are in good agreement with those observed, namely a retorting rate of 12 cm/hr, a local heating rate of 7°C/min, peak temperatures around 900°C, and a yield of 90% FA.

30215 (SAND—80-1470) **Oil shale programs. Seventeenth quarter report, January-March 1980.** Stevens, A.L. (ed.). (Sandia National Labs., Albuquerque, NM (USA)). Jul 1980. Contract AC04-76DP00789. 70p. NTIS, PC A04/MF A01.

This document is the seventeenth in a continuing series of quarterly reports, and describes the Sandia National Laboratories oil shale activities during the period between January 1, 1980 and March 31, 1980. Sandia's major role in the DOE Fossil Energy in situ oil shale program is to provide a quantitative evaluation to DOE of the field projects being supported by DOE/FE in the development of commercial in situ oil shale processes. This requires the deployment of instrumentation systems and the application of analysis techniques to evaluate key procedures and operations. In order to fulfill this responsibility, it is necessary to develop new and advanced instrumentation systems and associated deployment, recording, and analysis techniques that are unique to the field project needs. In addition, a rock mechanics program provides material properties, material response models, and computational methods for use in the design, analysis, and evaluation functions. This report describes detailed activities in these project areas over the last quarter.

SURFACE METHODS

REFER ALSO TO CITATION(S) 30207, 30221

30216 **SNG from eastern oil shale via the HYTORT process.** Feldkirchner, H.L.; Weil, S.A.; Janka, J.C.; Punwani, D.V. Chicago, IL; Institute of Gas Technology (1980). 21p. (CONF-800580—2).

From American Gas Association transmission conference; Salt Lake City, UT, USA (5 May 1980).

Work has shown that, if retorted in a hydrogen atmosphere at elevated pressures (via the HYTORT Process), eastern Devonian shales can be a potential source of synthetic gaseous or liquid fuels. Experimental work has been done in equipment ranging in size from a small laboratory thermobalannce to a large 1 ton/h process development unit. This work has shown that hydrogen retorting of these shales can give organic carbon recoveries from 2 to 2.5 times those that can be achieved by conventional retorting. This work, supported by process and economic studies, has confirmed the technical and economic feasibility of the HYTORT Process. 6 figures, 6 tables.

PROPERTIES AND COMPOSITION

REFER ALSO TO CITATION(S) 30215

30217 (FE—2346-68) **Fracture toughness of Antrim shale.** Kim, K.; Mubeen, A. (Michigan Technological Univ., Houghton (USA). Dept. of Mining Engineering). May 1980. Contract AC01-76ET12153. 20p. NTIS, PC A02/MF A01.

Fracture toughness of Antrim shale cores from Dow Chemical's Sanilac County test site in Michigan were measured by the burst test method developed by Clifton et al. (1976). These tests were conducted to establish a preliminary data base to be used for the designing of a bed preparation method and prediction of rock fracture behavior under various loading conditions such as explosives and hydraulic fracturing for in-situ processing of oil shale. The test method was chosen because the thick-walled cylinder provides a loading and specimen configuration similar to in-situ hydraulic fracturing operations and the specimens can be conveniently prepared from diamond drill cores for laboratory tests. Further, the nature of variation of crack tip stress intensity in this specimen is such that K/

sub IC/ does not depend on initial crack length, and crack propagation need not be monitored. The test results show that the fracture toughness of typical Antrim shale core range from 930 to 1080 psi √in. while the limestone specimens, a basement rock, range from 1240 to 1430 psi √in. These values are close to that of lean Western oil shale from Anvil point, Colorado (Schmidt, 1977), i.e., 980 psi √in.

30218 (LBL—9702) **On-line Zeeman atomic absorption spectroscopy for mercury analysis in oil shale gases. Final report.** Girvin, D.C.; Fox, J.P. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 1 Aug 1979. Contract W-7405-ENG-48. 119p. NTIS, PC A06/MF A01.

The technique utilizes ZAA for on-line measurement of mercury in the presence of smoke, organic vapors, and oil mist in offgases from oil shale processing plants. The spectrometer utilizes a new flow-through stainless steel (SS) furnace maintained at 900°C by joule heating. Corrosion of the furnace by H_2S in the sample gas is minimized by diffusion of Al into the surface of the SS. Corrosion tests with 2% (v/v) H_2S at 1093°C gave an estimated furnace lifetime of three days. The instrumental response with this furnace is characterized by a detection limit (DL) of 2 ppB, a linear response up to 100 ppB, and a precision of +- 7% or better. In the 50 ppB to 1.6 ppM range a furnace with a 5 cm optical absorption tube yields a DL of 10 ppB, a linear response up to 800 ppB, and a precision of +- 10% or better. Sample gas flow rates can be varied between 400 and 4000 scc/min for either furance.

30219 (MLM—2736) **Use of pulsed NMR to estimate the fuel yield of eastern gas shales.** Craft, B.D.; Attalla, A. (Mound Facility, Miamisburg, OH (USA)). 16 Jul 1980. Contract AC04-76DP00053. 16p. NTIS, PC A02/MF A01.

A pulsed NMR (nuclear magnetic resonance) technique was applied to the estimation of fuel yield of Devonian gas shale. NMR proton spins were correlated with oil yield, with hydrocarbon gas yield, and with percent organic carbon as determined by material balance assay. Correlation coefficients of approximately 0.85 were obtained. Improvement in correlation is limited by the imprecision of the material balance assay at the relatively low fuel levels encountered with the various shale samples.

DIRECT USES AND BY-PRODUCTS

30220 (EPRI-AP—1361) **Logistics management of Paraho residual shale oil. Final report.** Gunberger, G.A. (Radian Corp., Pasadena, CA (USA)). Mar 1980. 89p. NTIS, PC A05/MF A01.

In January of 1977 the Paraho Development Company under contract with the United States Navy began a semi-works project to produce and refine up to 100,000 barrels of crude shale oil. Although the primary objective of the project was to produce specification turbine and diesel transportation fuels for field testing by the military field testing, the full-scale refinery run also produced a substantial quantity of hydrotreated shale oil residue. In 1978 the Electric Power Research Institute, recognizing the utilization potential of this material as a fuel for utility combustion turbines, obtained 4300 barrels of the residual shale oil product for future field testing. This report describes the processes involved in producing, handling, and storing the residual shale oil test material. The report also includes detailed chemical and physical analyses of the test material. In addition, guidelines which can be applied to future work with this type of synthetic fuel are included.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 30224

ENVIROMENTAL ASPECTS

REFER ALSO TO CITATION(S) 30140, 31154, 31167, 31230, 31239

30221 (DOE/EV—0086) **Paraho environmental data. Part I. Process characterization. Par II. Air quality. Part III. Water quality.** Heistand, R.N.; Atwood, R.A.; Richardson, K.L. (Development Engineering, Inc., Rifle, CO (USA)). Jun 1980. Contract AC02-78EV04708. 352p. NTIS, PC A16/MF A01.

From 1973 to 1978, Development Engineering, Inc. (DEI), a subsidiary of Paraho Development Corporation, demostrated the Paraho technology for surface oil shale retorting at Anvil Points, Colorado. A considerable amount of environmentally-related research was also conducted. This body of data represents the most comprehensive environmental data base relating to surface retorting that is currently available. In order to make this information available, the DOE Office of Environment has undertaken to compile, assemble, and publish this environmental data. The compilation has been prepared by DEI. This report includes the process characterization, air quality, and water quality categories.

30222 (NP—24448) **Revegetation and management of tailings sand slopes from tar sand extraction: 1978 results.** Rowell, M.J. (Syncrude Canada Ltd., Edmonton, Alberta). 1979. 145p. NTIS (US Sales Only), PC A07/MF A01.

The results are reported of research into the revegetation of two areas on a steeply sloping dike composed of tailings sand from tar sand extraction at the Great Canadian Oil Sand Limited plant at Fort McMurray, Alberta. One area was seeded with three pasture grasses and two legumes in 1971 after the slope surface had been mixed with peat to a depth of 15 cm. A second area had been amended with peat or peat and overburden and differing rates of fertilizer added. A mix containing nine grasses, four legumes, and oats, as a companion crop, was seeded in July 1976. The objectives of the research were to study methods for the establishment of a stable vegetative cover that would prevent erosion of the slope and, in time, might become a self maintaining unit. Tillage of soil amendments to a depth of 15 cm and 30 cm were compared in promoting deeper rooting and stabilizing of the slope.

30223 (NP—24449) **Reclamation research for the future at Syncrude Canada Ltd.: soil simulation-revegetation studies on tailings sand.** Fedkenheuer, A.W.; Browne, J. (Syncrude Canada Ltd., Edmonton, Alberta). Dec 1979. 8p. NTIS (US Sales Only), PC A02/MF A01.

In response to the rising demand for energy in today's world, oil extracted from oil sands has become a viable energy source. Syncrude Canada Ltd. is a 2.2 billion dollar oil sands surface mining and processing venture situated in the Athabasca oil sands of northeastern Alberta. It is located near the town of Fort McMurray approximately 420 km north of Edmonton. During its planned 25 years of mine life, Syncrude expects to produce more than 1 billion barrels of oil from a 2800 ha mine area. Syncrude is committed to reclaiming this immense mine area. The reclamation objective is to return the disturbed site to a vegetative cover having a productivity which is equal to or greater than that which existed prior to disturbance. The reclaimed area must also be compatible with the neighboring natural areas. To accomplish this the vast quantities of tailings sand (that is, the leftover sand from which the oil has been extracted) must be reformed into a soil which is capable of supporting native plant communities. Researchers at Syncrude are looking for ways to use indigenous materials with the tailings sand to simulate a naturally-formed soil. Native plant species are being tested to see how well they will grow in such simulated soils and to evaluate their potential for use in large scale reclamation projects. This brochure describes the soil simulation-revegetation experiments going on at Syncrude.

30224 (PB—297096) **Health and environmental effects of oil shale technology. A workshop summary and panel reports.** Brown, R. (ed.). (Mitre Corp., McLean, VA (USA). METREK Div.). May 1979. Contract AC01-79EV10018. 278p. (DOE/HEW/EPA—02; MTR—79W00136). NTIS, PC A13/MF A01.

This report is the result of a workshop which addressed the health and environmental effects of oil shale technology. The purpose of this workshop were: to assemble biomedical and environmental scientists, representative of a broad range of disciplines, to address current developments in oil shale technology; to review and identify specific health and environmental issues and problems associated with the development and commercialization of oil shale technology; and to consider the research strategies required to address them and to identify the requisite research information needs, expressed via detailed task statements, for resolving the uncertainties of assessing the relevant impacts of oil shale technology. Throughout the workshop, attendees participated in six panels: health effects; air quality; water quantity, quality, and aquatic ecology; terrestrial effects; ambient measuring and monitoring; and source characterization. This report contains a presentation of the highlights of the issues considered by the panels and the panel reports which contain specific information on environmental and health effects, information requirements, and detailed research statements.

30225 (UCRL—84557) **Comparative mammalian genetic toxicology of shale oil products assayed in vitro and in vivo.** Timourian, H.; Carrano, A.; Carver, J.; Felton, J.S.; Hatch, F.T.; Stuermer, D.S.; Thompson, L.H. (California Univ., Livermore (USA). Lawrence Livermore National Lab.). 17 Jul 1980. Contract W-7405-ENG-48. 25p. (CONF-800680—3). NTIS, PC A02/MF A01.

From Symposium on health effects investigations of oil shale development; Gatlinburg, TN, USA (23 Jun 1980).

The objective of this project is to determine the relative toxicity and mutagenicity (genetic toxicity) of crude and hydrotreated shale oil products from the Paraho surface retort. This was achieved by applying a battery of bioassays emphasizing mammalian systems and having both in vitro (cell culture supplemented with microsomes to allow metabolic activation) and short-term in vivo

components. The results may be compared with the results from bioassays conducted in other laboratories to obtain a basis to estimate health hazards to humans.

NUCLEAR FUELS

RESERVES

REFER ALSO TO CITATION(S) 30204, 30206

30226 (GJBX—138(80)) **Uranium hydrogeochemical and stream sediment reconnaissance of the Trinidad NTMS Quadrangle, Colorado, including concentrations of forty-two additional elements.** Shannon, S.S. Jr. (Los Alamos Scientific Lab., NM (USA)). May 1980. Contract AC13-76GJ01664. 156p. (LA—7345-MS(Suppl.)). NTIS, PC A08/MF A01.

Uranium and other elemental data resulting from the Hydrogeochemical and Stream Sediment Reconnaissance (HSSR) of the Trinidad National Topographic Map Series (NTMS) quadrangle, Colorado, by the Los Alamos Scientific Laboratory (LASL) are reported herein. This study was conducted as part of the United States Department of Energy's National Uranium Resource Evaluation (NURE), which is designed to provide improved estimates of the availability and economics of nuclear fuel resources and to make available to industry information for use in exploration and development of uranium resources. The HSSR data will ultimately be integrated with other NURE data (e.g., airborne radiometric surveys and geological investigations) to complete the entire NURE program. This report is a supplement to the HSSR uranium evaluation report for the Trinidad quadrange (Morris et al, 1978), which presented the field and uranium data for the 1060 water and 1240 sediment samples collected from 1768 locations in the quadrangle. The earlier report contains an evaluation of the uranium concentrations of the samples as well as descriptions of the geology, hydrology, climate, and uranium occurrences of the quadrange. This supplement presents the sediment field and uranium data again and the analyses of 42 other elements in the sediments. All uranium samples were redetermined by delayed-neutron counting (DNC) when the sediment samples were analyzed for 31 elements by neutron activation. For 99.6% of the sediment samples analyzed, the differences between the uranium contents first determined (Morris et al, 1978) and the analyses reported herein are less than 10%.

30227 (GJBX—148(80)) **Experimental leaching of uranium from tuffaceous rocks.** Goodell, P.C.; Trentham, R.C. (Texas Univ., El Paso (USA). Dept. of Geological Sciences). Jul 1980. Contract AC13-76GJ01664. 156p. NTIS, PC A08/MF A01.

The premise to be tested in this work is that felsic volcanic rocks particularly ash-flow tuffs, can serve as source rocks for certain uranium deposits. The applicability of this idea to several geologic environments is investigated. A genetic model is developed dealing with the behavior of uranium during and subsequent to ash-flow tuff deposition. It is based upon previously described investigations, geologic logic, data presented here, and speculation. Ash-flow tuff sequences described in the literature show significant alkali element variation, particularly in thick tuff units. Some variation is attributed to initial magma variations, whereas additional change may be produced during cooling and degassing of the tuff. Uranium variations have been documented in tuff sequences which are assumed to represent magmatic compositions. Uranium may be released during the initial degassing, during hydrothermal alteration, and/or during later diagenesis. Experimental studies have been designed and carried out to simulate natural leaching conditions such as might occur during diagenesis. Synthetic ground waters have been pumped through pulverized uraniferous vitrophyres. Major and minor element contents have been determined. The most significant chemical changes take place quickly, within a matter of days. Several starting and product leachant solutions were analyzed fluorimetrically for uranium. They show significant increases in uranium contents, from less than 1 ppB at the start to greater than 10 ppB maximu. Such leachant solutions might be significant transport agents of uranium given geologic time. Leaching at low temperatures appears to involve a thin surface reaction and diffusion layer. Both dissolution and ion exchange influence the leachant composition. It is also concluded that glassy ash-flow tuffs may serve as uranium source rocks during low temperature diagenetic changes.

30228 (GJO—100(80)) **Statistical data of the uranium industry.** (Department of Energy, Grand Junction, CO (USA). Grand Junction Office). 1 Jan 1980. Contract AC13-76GJ01664. 111p. NTIS, PC A06/MF A01.

This document is a compilation of historical facts and figures through 1979. These statistics are based primarily on information provided voluntarily by the uranium exploration, mining, and milling companies. The production, reserves, drilling, and production capability information has been reported in a manner which avoids disclosure of proprietary information. Only the totals for the $1.5 reserves are reported. Because of increased interest in higher cost resources for long range planning purposes, a section covering the distribution of $100 per pound reserves statistics has been newly included. A table of mill recovery ranges for the January 1, 1980 reserves has also been added to this year's edition. The section on domestic uranium production capability has been deleted this year but will be included next year. The January 1, 1980 potential resource estimates are unchanged from the January 1, 1979 estimates.

30229 (LA—7346-MS(Suppl.)) **Uranium hydrogeochemical and stream sediment reconnaissance of the Durango NTMS quadrangle, Colorado, including concentrations of forty-two additional elements.** Shannon, S.S. Jr. (Los Alamos Scientific Lab., NM (USA)). May 1980. Contract AC13-76GJ01664. 183p. (GJBX—139(80)). NTIS, PC A09/MF A01.

Uranium and other elemental data resulting from the Hydrogeochemical and Stream Sediment Reconnaissance (HSSR) of the Durango National Topographic Map Series (NTMS) quadrangle, Colorado, by the Los Alamos Scientific Laboratory (LASL) are reported herein. The LASL is responsible for conducting the HSSR primarily in the states of New Mexico, Colorado, Wyoming, Montana, and Alaska. This study was conducted as part of the United States Department of Energy's National Uranium Resource Evaluation (NURE), which is designed to provide improved estimates of the availability and economics of nuclear fuel resources and to make available to industry information for use in exploration and development of uranium resources. The HSSR data will ultimately be integrated with other NURE data (e.g., airborne radiometric surveys and geological investigations) to complete the entire NURE program. This report is a supplement to the HSSR uranium evaluation report for the Durango quadrangle which presented the field and uranium data for the 1518 water and 1604 sediment samples collected from 1804 locations in the quadrangle. The earlier report contains an evaluation of the uranium concentrations of the samples as well as descriptions of the geology, hydrology, climate, and uranium occurrences of the quadrangle. This supplement presents the sediment field and uranium data again and the analyses of 42 other elements in the sediments.

EXPLORATION

REFER ALSO TO CITATION(S) 30205

30230 (DP-MS—80-29) **Interpretation and display of the NURE data base using computer graphics.** Koller, G.R. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1980. Contract AC09-76SR00001. 31p. (CONF-800727—1). NTIS, PC A03/MF A01.

From Computer graphics conference; Cambridge, MA, USA (27 Jul 1980).

Computer graphics not only is an integral part of data reduction and interpretation, it is also a fundamental aid in the planning and forecasting of the National Uranium Resource Evaluation program at Savannah River Laboratory. Computer graphics not only allows more rapid execution of tasks which could be performed manually, but also presents scientists with new capabilities which would be exceedingly impractical to apply were it not for the application of computer graphics to a problem.

30231 (GJBX—134(80)) **Hydrogeochemical and stream sediment reconnaissance basic data for Corpus Christi NTMS quadrangle, Texas.** (Union Carbide Corp., Oak Ridge, TN (USA). Nuclear Div.). 31 May 1980. Contract W-7405-ENG-26. 328p. (K/UR—138). PC $18.50/MF $3.50.

Results of a reconnaissance geochemical survey of the Corpus Christi Quadrangle, Texas, are reported. Field and laboratory data are presented for 119 groundwater samples and 57 stream sediment samples. Also included is a brief discussion on the geology and hydrology of the quadrangle. Groundwater data indicate that uranium concentrations above the 85th percentile occur primarily in a trend in western Nueces County. With one exception, waters in the trend are produced from the Evangeline aquifer and have high values for selenium and strontium. Owing to urbanization, low topographic relief, and the presence of Recent-to-Pleistocene surface material, stream sediment data were found to be less than optimum for the determination of the potential for uranium mineralization, and variation in uranium concentrations between units may simply reflect lithologic differences.

30232 (GJBX—136(80)) **Near-surface moisture and biomass influences on the reliability of aerial radiometric surveys as a measure of natural radioelement concentrations.** Norwine, J.R.; Hansen, D.J.; Saunders, D.F.; Galbraith, J.H. (Texas Instruments, Inc., Dallas

(USA). Airborne Geophysical Services). 28 Sep 1979. Contract AC13-76GJ01664. 151p. NTIS, PC A08/MF A01.

Significant differences in aerial radiometric system calibration constants in humid-forested (Portland quadrangle) and desert (Lake Mead test strip) regions indicated the probability of substantial gamma-ray absorption by soil moisture in humid areas. A set of test quadrangles was selected to investigate relationships among a group of environmental variables and ratios of whole-quadrangle mean (X) stream sediment uranium (U) and thorium (Th) contents to corresponding mean aerial radiometric uranium and thorium measurements. It was assumed that stream sediment values might be sufficiently representative of the average surface radioelement concentrations to be used in ground-calibrating the aerial systems. Preliminary testing established strong statistical correlations between the radioelement ratios and moisture and biomass variables. However, it is recognized that moisture and biomass relationships represent a variety of variables affecting the aerial gamma-ray measurements, such as soil formation, including weathering effects. Also, the data suggested that in certain very humid areas placering effects caused the mean thorium and uranium content of stream sediments to be much greater than actual concentrations in the average surface rocks. These effects appeared to be minimal in the arid regions, where the stream sediment data were more representative of the surface materials in general. These observations prompted a follow-up study using surface-to-aerial ratios based on analyses of surface samples in humid regions and including the stream sediment-to-aerial data ratios only for the relatively arid areas. Multiple linear regression analyses of the data indicated two-variable models would provide reasonable correction factors for aerial data obtained in humid environments.

30233 (GJBX—137(80)(Vol.1)) **Interpretation methods test report for NURE aerial radiometric and geochemical data. Volume 1. Text.** (Texas Instruments, Inc., Dallas (USA)). Mar 1980. Contract AC13-76GJ01664. 211p. NTIS, PC A10/MF A01.

Methods to be used in processing and interpreting Aerial Radiometric Reconnaissance (AAR) and Hydrogeochemical and Stream Sediment (HSSR) survey data for the 116 priority "A" quadrangles under Texas Instruments Interpretation Services subcontract of the National Uranium Resource Evaluation program were tested on selected quadrangles. Examples of the data products to be prepared and presented to the quadrangle evaluators for each of the quadrangles are included in this report along with an outline of the rationale for their creation. Quadrangles selected for testing are: Rawlins, Denver, Spokane, and Ritzville for AAR tests; and Seguin, Pueblo, and Austin for HSSR tests. Processing methods and data products for ARR data were selected to facilitate the identification of possible uranium source-rock areas and potential host rocks based on the measured abundances of U, Th, and K. Ground-water and stream-sediment data processing concentrated on removing the anomaly-masking effects of differences in drainage area and wide fluctuations of geochemically dead matrix constituents such as quartz, feldspar, and mica in stream sediments or pure water in the case of water samples. In general, both approaches are seeking significant enrichments or depletions of uranium relative to geochemically related elements as a supplement to the conventional anomaly hunting.

30234 (GJBX—137(80)(Vol.2)) **Interpretation methods test report for NURE aerial radiometric and geochemical data. Volume 2. Maps.** (Texas Instruments, Inc., Dallas (USA)). Mar 1980. Contract AC13-76GJ01664. 66p. NTIS, PC A04/MF A01.

Volume 2 contains maps from the Rawlins, Denver, Spokane, and Ritzville quadrangles.

30235 (LA—7668-MS) **Uranium hydrogeochemical and stream sediment reconnaissance data release for the Butte NTMS Quadrangle, Montana, including concentrations of forty-two additional elements.** Broxton, D.E.; George, W.E.; Montoya, J.V.; Martell, C.J.; Hensley, W.K.; Hanks, D. (Los Alamos Scientific Lab., NM (USA)). May 1980. Contract AC13-76GJ01664. 307p. NTIS, PC A14/MF A01.

This report contains data collected during a geochemical survey for uranium in the Butte National Topographic Map Series (NTMS) quadrangle of west-central Montana. Histograms and statistical data for uranium concentrations in water and sediment samples and thorium concentrations in sediment samples are given. Elemental concentration, field measurement, weather, geologic, and geographic data for each sample location are listed for waters and for sediments. Uranium/thorium ratios for sediment samples are also included. This report contains uranium analyses for water samples and multielement analyses for sediment samples. A supplemental report containing the results of multielement analyses of water samples will be open filed in the near future. Sediments were analyzed for uranium and thorium as well as aluminum, antimony, barium, beryllium, bismuth, cadmium, calcium, cerium, cesium, chlorine, chromium, cobalt, copper, dysprosium, europium, gold, hafnium, iron, lanthanum, lead, lithium, lutetium, magnesium, manganese, nickel, niobium, potassium, rubidium, samarium, scandium, silver, sodium, strontium, tantalum, terbium, tin, titanium, tungsten, vanadium, ytterbium, and zinc. All elemental analyses were performed at the LASL. Water samples were initially analyzed for uranium by fluorometry. All water samples containing more than 40 ppB uranium were reanalyzed by delayed-neutron counting (DNC). All sediments were analyzed for uranium by DNC. Other elemental concentrations in sediments were determined by neutron activation analysis for 31 elements, by x-ray fluorescence for 9 elements, and by arc-source emission spectrography for 2 elements. Analytical results for sediments are reported as parts per million. Descriptions of procedures used for analysis of water and sediment samples as well as analytical precisions and detection limits are given.

30236 (LA-UR—80-1542) **Percentile estimation using the normal and lognormal probability distribution.** Bement, T.R. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 13p. (CONF-800820—1). NTIS, PC A02/MF A01.

From American Statistical Society meeting; Houston, TX, USA (11 Aug 1980).

Implicitly or explicitly percentile estimation is an important aspect of the analysis of aerial radiometric survey data. Standard deviation maps are produced for quadrangles which are surveyed as part of the National Uranium Resource Evaluation. These maps show where variables differ from their mean values by more than one, two or three standard deviations. Data may or may not be log-transformed prior to analysis. These maps have specific percentile interpretations only when proper distributional assumptions are met. Monte Carlo results are presented in this paper which show the consequences of estimating percentiles by: (1) assuming normality when the data are really from a lognormal distribution; and (2) assuming lognormality when the data are really from a normal distribution.

30237 (SAND—80-1107) **Zetatron neutron tube and pulse transformer for driving it: a transfer of technology to the private sector.** Volk, R.D. (Sandia National Labs., Albuquerque, NM (USA)). May 1980. Contract AC04-76DP00789. 12p. NTIS, PC A02/MF A01.

The fabrication, testing, and delivery of ten Zetatron tubes (for use in logging probes for U exploration) under Phase I of Contract 07-5363 was successfully completed by Kaman Sciences Corporation. Twelve starts were required to complete ten acceptable tubes. This is an excellent performance record for first-fabrication attempts of a tube design that was new to Kaman Sciences Corporation. The fabrication of test transformer and tube-transformer assemblies required under Phase II of the contract was satisfactorily completed. Testing of these components is still in progress.

30238 **Equipment for collecting sludge samples from Savannah River Plant waste tanks.** Allen, B.M. Jr. (E.I. du Pont de Nemours and Co., Inc., Aiken, SC). pp 386-390 of Proceedings of the 27th conference on remote systems technology. Wallin, D.R. (ed.). La Grange Park, IL; American Nuclear Society, Inc. (1980).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

A sampler was developed to take 25-l samples of sludge from Savannah River Plant waste tanks. The cylindrical sample vessel has a retractable nose section. Sludge enters an annular space at the nose section as the sampler is forced through the sludge layer with rigid drive pipes. Two samples have been taken and transported in a special cask to a waste processing research facility at the Savannah River Laboratory.

FEED PROCESSING

REFER ALSO TO CITATION(S) 30520

FUELS PRODUCTION AND PROPERTIES

REFER ALSO TO CITATION(S) 30251, 30325, 30331, 31031, 31051

30239 **Device for fracturing silicon-carbide coatings on nuclear-fuel particles.** Turner, L.J.; Willey, M.G.; Tiegs, S.M.; Van Cleve, J.E. Jr. US Patent Application 070,365. [nd]. 16p.

This invention is a device for fracturing particles. It is designed especially for use in hot cells designed for the handling of radioactive materials. In a typical application, the device is used to fracture a hard silicon-carbide coating present on carbon-matrix microspheres containing nuclear-fuel materials, such as uranium or thorium compounds. To promote remote control and facilitate maintenance, the particle breaker is pneumatically operated and contains no moving parts. It includes means for serially entraining the entrained particles on an anvil housed in a leak-tight chamber. The flow rate of the gas is at a value effecting fracture of the particles; preferably, it is at a value fracturing them into product particulates of fluidizable size. The chamber is provided with an outlet passage whose cross-sectional area decreases in the direction away from the

chamber. The outlet is connected tangentially to a vertically oriented vortex-flow separator for recovering the product particulates entrained in the gas outflow from the chamber. The invention can be used on a batch or continuous basis to fracture the silicon-carbide coatings on virtually all of the particles fed thereto.

30240 (ORNL/TM—7298) **Characterization and irradiation performance of HTGR Biso-coated fertile particles in HFIR experiments HT-28, -29, and -30.** Long, E.L. Jr.; Krautwasser, P.; Beatty, R.L.; Kania, M.J.; Morgan, C.S. Jr.; Yust, C.S. (Oak Ridge National Lab., TN (USA)). Jul 1980. Contract W-7405-ENG-26. 94p. NTIS, PC A05/MF A01.

Capsules HT-28, -29, and -30 were irradiated in the target region of the High Flux Isotope Reactor at ORNL to determine the relative fast-neutron stability of pyrolytic carbons that had been prepared in a small laboratory coating furnace with various deposition conditions. The pyrolytic carbon coatings of 22 batches of particles of HTGR design were characterized by various methods, including optical anisotropy measurements, hot gaseous chlorine leaching, plasma oxidation, small-angle x-ray scattering (SAXS) measurements, mercury intrusion, immersion density, and, in a few cases, neon-helium permeability measurements. The results of the above measurements were used to quantify microstructural differences between pyrolytic coatings derived at various conditions and to correlate the performance of the coatings with the measured properties. The most consistent results were obtained by comparing various pore size distributions within the coatings (determined from SAXS measurements) with immersion density, mercury intrusion, chlorine leaching, and neon-helium permeability results and with irradiation performance of the coatings. This study also demonstrated that care must be exercised if experiments on coatings containing inert carbon kernels that were codeposited along with dense thoria kernels are to yield meaningful results.

30241 Powder transfer in fuels refabrication by negative pressure pneumatic transport. Lyon, W.L. (Westinghouse Electric Corp., Pittsburgh, PA); Smeltzer, E.E.; Skriba, M.C. *Trans. Am. Nucl. Soc.;* **33**: 896-899(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30242 Development of nuclear fuel microsphere handling techniques and equipment. Mack, J.E.; Angelini, P.; Suchomel, R.R. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **33**: 899-901(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30243 Concepts for a remote fuel refabrication laboratory. Fortsch, M. (Fluor Engineers and Constructors, Irvine, CA); Nesbitt, J.F. *Trans. Am. Nucl. Soc.;* **33**: 902(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30244 System for measuring fission gas inventories of HTGR fuel particles. Robbins, J.M.; Kania, M.J.; Long, E.L. Jr.; Rainey, W.T. Jr. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **33**: 914(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30245 Concepts for a remote fuel refabrication laboratory. Fortsch, M. (Fluor Engineers and Constructors, Inc., Irvine, CA); Nesbitt, J.F. pp 197-200 of Proceedings of the 27th conference on remote systems technology. Wallin, D.R. (ed.). La Grange Park, IL; American Nuclear Society, Inc. (1979).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

A conceptual design study was made to identify the required design criteria for a facility dedicated to demonstrating the technological base and operational aspects of radioactive nuclear fuel refabrication. This conceptual design of a remote fuel refabrication laboratory provides for an extremely versatile facility in which advanced remote handling equipment and future fuel fabrication equipment can be tested and demonstrated. Remote techniques can be developed, optimized, and demonstrated. The remote operation of fuel fabrication equipment and its remote maintenance are the two major functions that will be required in a facility intended for the refabrication of recycled or mixed-oxide fuels.

30246 Oak Ridge National Laboratory Ceramic Fuels Alpha Facility. Williams, L.C.; Bomar, E.S. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **33**: 879-880(1978). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

SPENT FUELS REPROCESSING

REFER ALSO TO CITATION(S) 30245, 30268, 30276, 30277, 30284, 30285, 30286, 30287, 30323, 30327, 31050

30247 (CONF-800743—1) **Recovery of plutonium from HEPA filters by Ce(IV)-promoted dissolution of PuO_2 and recycle of the cerium promoter.** Leuze, R.E.; Bond, W.D.; Scheitlin, F.M. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 33p. NTIS, PC A03/MF A01.

From International conference on nuclear waste transmutation; Austin, TX, USA (22 Jul 1980).

The experimental studies carried out included (1) the electrolytic production of Ce(IV) from Ce(III), (2) the leaching of refractory PuO_2 from HEPA filter materials with maintenance of Ce(IV) concentrations by anodic oxidation during leaching, and (3) evaluation of methods for contacting the HEPA solids with the leaching solution and for separating the solid residue from the leaching liquor. Anodic oxidation of Ce(III) was accomplished with an electric current efficiency of about 85% at current densities of 0.04 to 0.4 A/dm^2 at a platinum anode. Refractory PuO_2 was dissolved by a 4.0 M HNO_3 - 0.1 M Ce(IV) solution in 1.5 h at 100°C using stirred-contact leaching of the solids or by recirculating the leachant through a packed column of the solids. Cerium (IV) concentrations were maintained continuously by anodic oxidation throughout leaching. Dissolution times up to 10 h were required unless the HEPA media were oxidized initially in air at 300°C to destroy carbonaceous species which consumed Ce(IV) more rapidly than it could be regenerated by anodic oxidation. Leaching solids in packed columns avoided the relatively difficult liquid-solids separation by centrifugation which was required after stirred-contact leaching; however, the solids handling difficulties associated with charging and discharging of the packed columns in a remote environment remain a significant design obstacle. A chemical flowsheet is proposed for the recovery of actinides from HEPA filters. A 4 M HNO_3 - 0.1 M Ce(IV) nitrate solution is used as the leachant and the Ce(III) is recycled to the leaching operation using bidentate solvent extraction.

30248 (DP-MS—80-36) **Recovery of americium-241 from aged plutonium metal.** Gray, L.W.; Burney, G.A.; Reilly, T.A.; Wilson, T.W.; McKibben, J.M. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1980. Contract AC09-76SR00001. 23p. (CONF-800814—4). NTIS, PC A02/MF A01.

From American chemical society meeting; San Francisco, CA, USA (24 Aug 1980).

After separation and purification, both actinides were precipitated as oxalates and calcined. A large-scale process was developed using dissolution, separation, purification, precipitation, and calcination. Efforts were made to control corrosion, to avoid product contamination, to keep the volume of process and waste solutions manageable, and to denitrate solutions with formic acid. The Multipurpose Processing Facility (MPPF), designed for recovery of transplutonium isotopes, was used for the first time for the precipitation and calcination of americium. Also, for the first time,, large-scale formic acid denitration was performed in a canyon vessel at SRP.

30249 History and status of the Hot Fuel Examination Facility complex. Bacca, J.P. (Argonne National Lab., Idaho Falls, ID). pp 10-14 of Proceedings of the 27th conference on remote systems technology. Wallin, D.R. (ed.). La Grange Park, IL; American Nuclear Society, Inc. (1980).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

The Hot Fuel Examination Facility (HFEF) complex, located at the Argonne-West Site of the Idaho National Engineering Laboratory, comprises two hot cell facilities - HFEF/South (HFEF/S) and HFEF/North (HFEF/N). From 1964 to 1968, HFEF/S was used for remote reprocessing and refabrication of Experimental Breeder Reactor-II (ERB-II) fuel. Since then, HFEF/S has been used for EBR-II support, especially spent fuel handling, and for the nondestructive examination of experiments irradiated in EBR-II for US breeder reactor programs. The HFEF/N is a large modern alpha-gamma facility. It has operated since March 1975 for nondestructive and destructive examinations of fast reactor fuel and material experiments and large reactor safety irradiation experiments (such as sodium loops).

30250 (RHO-CD—519) **Uranium trioxide (UO_3) plant chemical flowsheet.** Raab, G.J.; Schmidt, W.C. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). Nov 1978. Contract AC06-77RL01030. 8p. NTIS, PC A02/MF A01.

The UO_3 Plant complements the Purex Plant to further process and refine the uranium recovered from irradiated fuel elements. The major unit operations performed at the UO_3 Plant are concentration, calcination, packaging of the UO_3 product, and acid recovery. This document describes these unit operations and presents an over all chemical flowsheet for the UO_3 Plant. (DLC)

30251 (RHO-CD—520(Rev.1)) **Uranium trioxide (UO_3) plant startup criteria.** Schmidt, W.C. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). Jan 1979. Contract AC06-77RL01030. 13p. NTIS, PC A02/MF A01.

The overall startup criteria to be used as a basis for startup planning, scheduling, and plant preparation are shown. Additional information to supplement these criteria is also discussed.

30252 Apparatus for shearing spent nuclear fuel assemblies. Weil, B.S.; Metz, C.F. III. (to Dept. of Energy). US Patent 4,186,657. 5 Feb 1980. Filed date 7 Dec 1978. 4p.

PAT-APPL-967,469.

A method and apparatus are described for shearing spent nuclear fuel assemblies of the type comprising an array of fuel pins disposed within an outer metal shell or shroud. A spent fuel assembly is first compacted in a known manner and then incrementally sheared using fixed and movable shear blades having matched laterally projecting teeth which slidably intermesh to provide the desired shearing action. Incremental advancement of the fuel assembly after each shear cycle is limited to a distance corresponding to the lateral projection of the teeth to ensure fuel assembly breakup into small uniform segments which are amenable to remote chemical processing.

30253 Battelle Hot Cell Laboratory. Klingensmith, R.W. (Battelle Columbus Labs., OH). pp 38-41 of Proceedings of the 27th conference on remote systems technology. Wallin, D.R. (ed.). La Grange Park, IL; American Nuclear Society, Inc. (1980).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

The Battelle Hot Cell Laboratory has evolved along with the nuclear power industry, and now is primarily concerned with postirradiation examination of fuel rods and assemblies, evaluation of materials properties, and pressure vessel surveillance. The laboratory is the only independent facility in the US where complete examinations of full-size light water reactor assemblies and rods are routinely conducted. It comprises a large high-energy cell, two beta-gamma cells, a series of alpha cells, and a variety of necessary support facilities.

30254 Receiving and shearing spent fuel. Siemens, D.H.; Berger, D.N.; Carter, J.G. (Battelle Pacific Northwest Labs., Richland, WA). pp 252-256 of Proceedings of the 27th conference on remote systems technology. Wallin, D.R. (ed.). La Grange Park, IL; American Nuclear Society Inc. (1980).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

A unique system was designed and constructed to receive and shear (chop) spent-fuel assemblies. Space limitations prevented direct use of most state-of-the-art technology. A major portion of the equipment had to be installed in an existing, contaminated hot cell. As a result, design for remote installation, as well as for remote operation, was required. The total system was successfully used to receive and shear six irradiated pressurized water reactor fuel assemblies, which satisfied programmatic requirements.

30255 Spent-fuel disassembly and canning programs at the Barnwell Nuclear Fuel Plant (BNFP). Townes, G.A. (Applied General Nuclear Services, Barnwell, SC). *Trans. Am. Nucl. Soc.;* **33**: 892-893(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30256 Remote handling systems at the Barnwell Nuclear Fuel Plant: an overview. Atchinson, G.; Cottrell, J.E.; Sears, L.F. (Allied General Nuclear Services, Barnwell, SC). *Trans. Am. Nucl. Soc.;* **33**: 893-894(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30257 SRP Purex Plant: 25 years of successful remote operation. McKibben, J.M.; Starks, J.B.; Brown, J.K. (E. I. duPont de Nemours and Co., Aiken, SC). *Trans. Am. Nucl. Soc.;* **33**: 894-895(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30258 Mockup testing of remote systems for zirconium fuel dissolution process at the Idaho Chemical Processing Plant. Paige, D.M. (Exxon Nuclear Idaho, Idaho Falls, ID). *Trans. Am. Nucl. Soc.;* **33**: 933-935(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30259 Availability calculations for nuclear material processing facilities. Holder, N.D. (General Atomic Co., San Diego, CA). *Trans. Am. Nucl. Soc.;* **33**: 935-936(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 30256, 30267, 30328, 31060

30260 (AGNS—35900-CONF-63) **Spent-fuel disassembly and canning programs at the Barnwell Nuclear Fuel Plant (BNFP).** Townes, G.A. (Allied-General Nuclear Services, Barnwell, SC (USA)). Feb 1980. Contract AC09-78ET35900. 6p. (CONF-800901—2). NTIS, PC A02/MF A01.

From Symposium on intermediate range atmospheric transport processes and technology assessment; Gatlinburg, TN, USA (29 Sep 1980).

Doubling pool storage and tripling truck cask shipping capability appear feasible based on preliminary development work performed at the BNFP. This would be accomplished by disassembly of the fuel assembly and canning of the fuel pins. The dry, remote disassembly and canning in the headend cells offer adequate rates, easily controlled operator exposure, and visual inspection of the fuel pins and operations through shielded windows.

30261 (HEDL-SA—2054-FP) **Elevated temperature testing of spent nuclear fuel rods.** Stellrecht, D.E.; Pasupathi, V.; Krogness, J.C. (Battelle Columbus Labs., OH (USA); Hanford Engineering Development Lab., Richland, WA (USA)). Apr 1980. Contract AC14-76FF02170. 20p. (CONF-800607—64). NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; Las Vegas, NV, USA (8 Jun 1980).

The results of the first three tests have indicated that the experimental equipment designed for this program has functioned well and that the equipment and techniques constitute a viable test method for determining the stability of spent nuclear fuel rods at elevated temperatures. Test capsules are reusable and additional testing is feasible.

30262 (ORNL/SUB—79/13866/1) **Fleet servicing facilities for servicing, maintaining, and testing rail and truck radioactive waste transport systems: functional requirements, technical design concepts and options cost estimates and comparisons.** Watson, C.D.; Hudson, B.J.; Keith, D.A.; Preston, M.K. Jr.; McCreery, P.N.; Knox, W.; Easterling, E.M.; Lamprey, A.S.; Wiedemann, G. (Allied-General Nuclear Services, Barnwell, SC (USA)). May 1980. Contract AC04-76DP00789; W-7405-ENG-26. 150p. NTIS, PC A07/MF A01.

This is a resource document which examines feasibility design concepts and feasibility studies of a Fleet Servicing Facility (FSF). Such a facility is intended to be used for routine servicing, preventive maintenance, and for performing requalification license compliance tests and inspections, minor repairs, and decontamination of both the transportation casks and their associated rail cars or tractor-trailers. None of the United States' waste handling plants presently receiving radioactive wastes have an on-site FSF, nor is there an existing third party facility providing these services. This situation has caused the General Accounting Office to express concern regarding the quality of waste transport system maintenance once the system is placed into service. Thus, a need is indicated for FSF's, or their equivalent, at various radioactive materials receiving sites. In this report, three forms of FSF's solely for spent fuel transport systems were examined: independent, integrated, and colocated. The independent concept was already the subject of a detailed report and is extensively referenced in this document so that capital cost comparisons of the three concepts could be made. These facilities probably could service high-level, intermediate-level, low-level, or other waste transportation systems with minor modification, but this study did not include any system other than spent fuel. Both the Integrated and Colocated concepts were assumed to be associated with some radioactive materials handling facility such as an AFR repository.

30263 (SAND—80-1013) **Development of laser-based techniques for identification of breached nuclear fuel elements in storage. Progress report, 1 October 1978-1 September 1979.** Anderson, R.J.; Esherick, P. (Sandia National Labs., Albuquerque, NM (USA)). Jun 1980. Contract AC04-76DP00789. 26p. NTIS, PC A03/MF A01.

From many possible laser-based techniques of atomic and molecular spectroscopy we have selected multiphoton ionization spectroscopy (MIS) as that one technique which best conforms to the constraints imposed by the problem of identifying breached nuclear fuel assemblies in storage. We describe experiments utilizing MIS to specifically and sensitively detect xenon (Xe) and nitric oxide (NO). We therefore experimentally demonstrate the applicability of this technique to the detection of volatile fission products leaking from breached nuclear fuel assemblies stored in water cooled basins. Even for the non-ideal circumstances of these preliminary experiments, we estimate a detection limit of 10^{10} atoms/cm^3 for xenon, roughly 1% of the atmospheric content of xenon at sea level.

WASTE MANAGEMENT

30264 (LA-UR—80-1794) **A 1-nCi/g sensitivity transuranic waste assay system using pulsed neutron interrogation.** Kunz, W.E.; Atencio, J.D.; Caldwell, J.T. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 8p. (CONF-800655—6). NTIS, PC A02/MF A01.

From 21. annual meeting of the Institute of Nuclear Materials Management; Palm Beach, FL, USA (30 Jun 1980).

We have developed a pulsed thermal neutron interrogation system and have demonstrated a sub-1-nCi/g assay sensitivity for high density TRU wastes contained in 200-liter barrels. We detect prompt fission neutrons, resulting in greatly enhanced sensitivity compared to techniques in which delayed fission neutrons are detected. We observe a linear assay response over at least three orders of magnitude in ^{235}U (or ^{239}Pu) mass. We also have measured a flat (to +-10%) interrogation flux profile throughout the volume of a 200-liter barrel filled with 200 kg of sand and vermiculite, which indicates flatness of response to fissile material at different locations within the barrel.

30265 (NVO—196-15) **Nevada nuclear waste storage investigations. Quarterly report, January-March 1980.** (Department of Energy, Las Vegas, NV (USA). Nevada Operations Office). Jun 1980. 65p. NTIS, PC A04/MF A01.

The Nevada Nuclear Waste Storage Investigations (NNWSI) consist of a variety of studies and evaluations in support of the US Nuclear Waste Management Program. The NNWSI are primarily oriented towards developing or improving the technology of nuclear waste storage and disposal and determining whether selected underground rock media on or adjoining the Nevada Test Site (NTS) are technically acceptable for a licensed, permanent, high-level nuclear waste repository. The NNWSI Project for FY 1980 is comprised of eight tasks which are divided into subtasks: weapons test seismic investigations, geologic and hydrologic investigations, media investigations, engineering and technical support, quality assurance, technical review, Climax spent fuel test, and National Waste Terminal Storage Program support. (DLC)

WASTE PROCESSING

REFER ALSO TO CITATION(S) 30247, 30299, 31050, 31446

30266 (ARH-SA—203) **Bidentate organophosphorus extraction of americium and plutonium from Hanford Plutonium Reclamation Facility waste.** Schulz, W.W. (Atlantic Richfield Hanford Co., Richland, WA (USA)). Sep 1974. Contract AM06-76RL02130. 65p. (CONF-750607—57). NTIS, PC A04/MF A01.

From American Nuclear Society meeting; New Orleans, LA, USA (8 Jun 1975).

Applicability of bidentate organiphosphorus reagents to recovery of americium and plutonium from Hanford's Plutonium Reclamation Facility acid (~ 2M HNO_3) waste stream (CAW solution) was studied. A solvent extraction process which employs a 30% DHDECMP (dihexyl-N, N-diethylcarbamylmethylene phosphonate)-CCl_4 extractant was devised and successfully tested in mixer-settler runs with actual CAW solution. Substitution of DHDECMP for DBBP eliminates the need to perform careful neutralization of unbuffered CAW soluton and increases overall americium recovery from the present 60 to 80% level to ≧ 90%. Disadvantages to such substitution include the high cost (~ $50/liter) of DHDECMP and the need to purify it [by acid (6M HCl) hydrolysis and alkaline washing] from small amounts of an unidentified impurity which prevents stripping of americium with dilute HNO_3. Distribution data obtained in this study confirm Siddall's earlier contention that bidentate organophosphorus regents can be used to remove actinides from concentrated high-level Purex process acid waste; a conceptual flowsheet for such an extraction process is given.

30267 (CONF-800607—79) **Spent LWR fuel encapsulation and dry storage demonstration.** Bahorich, R.J.; Durrill, D.C.; Cross, T.E.; Unterzuber, R. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Advanced Energy Systems Div.). 1980. Contract AC08-76NV00597. 34p. NTIS, PC A03/MF A01.

From American Nuclear Society annual meeting; Las Vegas, NV, USA (8 Jun 1980).

In 1977 the Spent Fuel Handling and Packaging Program (SFHPP) was initiated by the Department of Energy to develop and test the capability to satisfactorily encapsulate typical spent fuel assemblies from commercial light-water nuclear power plants and to establish the suitability of one or more surface and near surface concepts for the interim dry storage of the encapsulated spent fuel assemblies. The E-MAD Facility at the Nevada Test Site, which is operated for the Department of Energy by the Advanced Energy Systems Division (AESD) of the Westinghouse Electric Corporation, was chosen as the location for this demonstration because of its extensive existing capabilities for handling highly radioactive components and because of the desirable site characteristics for the proposed storage concepts. This paper describes the remote operations related to the process steps of handling, encapsulating and subsequent dry storage of spent fuel in support of the Demonstration Program.

30268 (CONF-800743—5) **Experimental studies at the Idaho Chemical Processing Plant on actinide partitioning from acidic nuclear wastes.** McIssaac, L.D.; Baker, J.D.; Meikrantz, D.H.; Schroeder, N.C. (Idaho National Engineering Lab., Idaho Falls (USA)). 1980. Contract AC07-76ID01570. 24p. NTIS, PC A02/MF A01.

From International conference on nuclear waste transmutation; Austin, TX, USA (22 Jul 1980).

Wastes generated at ICPP and in the reprocessing of LWR fuel is discussed separately. DHDECMP is used as extractant. Studies on DHDECMP purification and toxicity, diluent effects, reaction kinetics, radiolysis, mixer-settler performance, etc. are reported. 10 tables, 3 figures. (DLC)

30269 (CONF-800914—3) **Microwave energy for post-calcination treatment of high-level nuclear wastes.** Gombert, D.; Priebe, S.J.; Berreth, J.R. (Exxon Nuclear Idaho Co., Inc., Idaho Falls (USA)). 1980. Contract AC07-79ID01675. 10p. NTIS, PC A02/MF A01.

From IEEE meeting; Cincinnati, OH, USA (29 Sep 1980). Portions of document are illegible.

High-level radioactive wastes generated from nuclear fuel reprocessing require treatment for effective long-term storage. Heating by microwave energy is explored in processing of two possible waste forms: (1) drying of a pelleted form of calcined waste; and (2) vitrification of calcined waste. It is shown that residence times for these processes can be greatly reduced when using microwave energy rather than conventional heating sources, without affecting product properties. Compounds in the waste and in the glass frit additives couple very well with the 2.45 GHz microwave field so that no special microwave absorbers are necessary.

30270 (DOE/SR-WM—79-2) **Long-term high-level waste technology. Composite quarterly technical report, October-December 1979.** Cornman, W.R. (comp.). (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Jun 1980. 233p. NTIS, PC A11/MF A01.

This document summarizes work for the immobilization of high-level radioactive wastes from the chemical reprocessing of nuclear reactor fuels. The progress is reported in two main areas: site technology, and alternative waste form development. (DLC)

30271 (DP-MS—80-27) **Significance of radiation effects in solid radioactive waste.** Permar, P.H.; McDonell, W.R. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1980. Contract AC09-76SR00001. 55p. (CONF-800609—5). NTIS, PC A04/MF A01.

From 10. international symposium on effects of radiation on materials; Savannah, GA, USA (3 Jun 1980).

Proposed NRC criteria for disposal of high-level nuclear waste require development of waste packages to contain radionuclide for at least 1000 years, and design of repositories to prevent radionuclide release at an annual rate greater than 1 part in 100,000 of the total activity. The high-level wastes that are now temporarily stored as aqueous salts, sludges, and calcines must be converted to high-integrity solid forms that resist deterioration from radiation and other effects of long-term storage. Spent fuel may be encapsulated for similar long-term storage. Candidate waste forms beside the spent fuel elements themselves, include borosilicate and related glasses, mineral-like crystalline ceramics, concrete formulations, and metal-matrix glass or ceramic composites. these waste forms will sustain damage produced by beta-gamma radiation up to 10^{12} rads, by alpha radiation up to 10^{19} particles/g, by internal helium generation greater than about 0.1 atom percent, and by the atom transmutations accompanying radioactive decay. Current data indicate that under these conditions the glass forms suffer only minor volume changes, stored energy deposition, and leachability effects. The crystalline ceramics appear susceptible to the potentially more severe alterations accompanying metamictization and natural analogs of candidate materials are being examined to establish their suitability as waste forms. Helium concentrations in the waste forms are generally below thresholds for severe damage in either glass or crystalline ceramics at low temperatures, but microstructural effects are not well characterized. Transmutation effects remain to be established.

30272 (DP-MS—80-35) **Recovery of Am-Cm from high-activity waste concentrate by in-canyon-tank precipitation as oxalates.** Gray, L.W.; Burney, G.A.; Wilson, T.W.; McKibben, J.M. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1980. Contract AC09-76SR00001. 23p. (CONF-800814—5). NTIS, PC A02/MF A01.

From American chemical society meeting; San Francisco, CA, USA (24 Aug 1980).

Savannah River Laboratory and Savannah River Plant have been separating actinides for more than 25 years. Work continues to upgrade processes and to initiate new processes. This report summarizes work on a precipitation process to separate kg amounts of Am and Cm from hundreds of kilograms of $NaNO_3$ and $Al(NO_3)_3$. The developed process includes formic acid denitration of the Am-Cm bearing streams for acid adjustment; oxalate precipitation of the Am-Cm; and Mn^{+2} catalyzed oxidation of oxalate in both the decanted supernate and the precipitated actinides. The new process generates one fourth the radioactive waste as the solvent extraction process which it replaced, and produces a cleaner feed solution for downstream processing to separate the Am and Cm before conversion to their respective oxides.

30273 (EGG-TF—5168) **Brief summary of slag handling options reviewed for the slagging pyrolysis incinerator in the transuranic waste treatment facility (TWIF) at the INEL.** Darnell, G.R. (EG and G Idaho, Inc., Idaho Falls (USA)). Jun 1980. Contract AC07-76ID01570. 35p. NTIS, PC A03/MF A01.

This report summarizes the technical problems associated with molten transuranic waste slag as it flows from the incinerator shaft (gasifier) of the slagging pyrolysis incinerator. It addresses essential gasifier seals, slag casting and pouring technology, and transportation and packaging problems. Areas requiring further study and testing are identified.

30274 (ENICO—1035) **Product removal nozzles for a fluidized-bed calciner.** Schindler, R.E.; Cogburn, G.L.; Schrader, J.D. (Exxon Nuclear Idaho Co., Inc., Idaho Falls (USA)). Jun 1980. Contract AC07-79ID01675. 63p. NTIS, PC A04/MF A01.

Granular solids formed by the fluidized-bed calcination of radioactive liquid wastes are discharged from the calciner into a pneumatic transport line. These solids are discharged at a controlled rate by product removal nozzles consisting of sections of pipe. Dilution air is introduced near the nozzle inlet to dilute the solids and provide an air velocity adequate to prevent solids deposition in the nozzle. Solids discharge rates are controlled by adjusting the dilution air input and the pressure difference across the nozzle. Product removal nozzles designed to remove calcined solids from a fluidized-bed calciner at controlled rates of 1 to 3 kg/min with a pressure drop of 7 to 13 kPa were tested. Major operating parameters are identified and recommended operating conditions established. Graphical capacity correlations are developed for sizing of the product removal nozzles.

30275 (HEDL-SA—1967) **Operation of the radioactive acid digestion test unit.** Blasewitz, A.G.; Allen, C.R.; Lerch, R.E.; Ely, P.C.; Richardson, G.L. (Hanford Engineering Development Lab., Richland, WA (USA)). 1980. Contract AC14-76FF02170. 19p. (CONF-800611—9). NTIS, PC A02/MF A01.

From International symposium on the management of alpha-contaminated wastes; Vienna, Austria (2 Jun 1980).

The Radioactive Acid Digestion Test Unit (RADTU) has been constructed at Hanford to demonstrate the application of the Acid Digestion Process for treating combustible transuranic wastes and scrap materials. The RADTU with its original tray digestion vessel has recently completed a six-month campaign processing potentially contaminated nonglovebox wastes from a Hanford plutonium facility. During this campaign, it processed 2100 kg of largely cellulosic wastes at an average sustained processing rate of 3 kg/h as limited by the water boiloff rate from the acid feeds. The on-line operating efficiency was nearly 50% on a twelve hour/day, five day/week basis. Following this campaign, a new annular high rate digester has been installed for testing. In preliminary tests with simulated wastes, the new digester demonstrated a sustained capacity of 10 kg/h with greatly improved intimacy of contact between the digestion acid and the waste. The new design also doubles the heat transfer surface, which with reduced heat loss area, is expected to provide at least three times the water boiloff rate of the previous tray digester design. Following shakedown testing with simulated and low-level wastes, the new unit will be used to process combustible plutonium scrap and waste from Hanford plutonium facilities for the purposes of volume reduction, plutonium recovery, and stabilization of the final waste form.

30276 (ORNL/MIT—300) **Analysis of barium hydroxide and calcium hydroxide slurry carbonation reactors.** Patch, K.D.; Hart, R.P.; Schumacher, W.A. (Massachusetts Inst. of Tech., Oak Ridge, TN (USA). School of Chemical Engineering Practice; Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 41p. NTIS, PC A03/MF A01.

The removal of CO_2 from air was investigated by using a continuous-agitated-slurry carbonation reactor containing either barium hydroxide [$Ba(OH)_2$] or calcium hydroxide [$Ca(OH)_2$]. Such a process would be applied to scrub $^{14}CO_2$ from stack gases at nuclear-fuel reprocessing plants. Decontamination factors were characterized for reactor conditions which could alter hydrodynamic behavior. An attempt was made to characterize reactor performance with models assuming both plug flow and various degrees of back-mixing in the gas phase. The $Ba(OH)_2$ slurry enabled increased conversion, but apparently the process was controlled under some conditions by phenomena differing from those observed for carbonation by $Ca(OH)_2$. Overall reaction mechanisms are postulated.

30277 (ORNL/TM—6983) **Actinide partitioning-transmutation program final report. III. Transmutation studies.** Wachter, J.W.; Croff, A.G. (Oak Ridge National Lab., TN (USA)). Jul 1980. Contract W-7405-ENG-26. 59p. NTIS, PC A04/MF A01.

Transmutation of the long-lived nuclides contained in fuel cycle wastes has been suggested as a means of reducing the long-term toxicity of the wastes. A comprehensive program to evaluate the feasibility and incentives for recovering the actinides from wastes (partitioning) and transmuting them to short-lived or stable nuclides has been in progress for 3 years under the direction of Oak Ridge National Laboratory (ORNL). This report constitutes the final assessment of transmutation in support of this program. Included are (1) a summary of recent transmutation literature, (2) a generic evaluation of actinide transmutation in thermal, fast, and other transmutation devices, (3) a preliminary evaluation of ^{99}Tc and ^{129}I transmutation, and (4) a characterization of a pressurized-water-reactor fuel cycle with and without provisions for actinide recovery and transmutation for use in other parts of the ORNL program. The principal conclusion of the report is that actinide transmutation is feasible in both thermal and fast reactors, subject to demonstrating satisfactory fuel performance, with relatively little impact on the reactor. It would also appear that additional transmutation studies are unwarranted until a firm decision to proceed with actinide transmutation has been made by the responsible authorities.

30278 (RFP—3079) **Recovery and purification of americium from molten salt extraction residues.** Navratil, J.D.; Martella, L.L.; Thompson, G.H. (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). 1980. Contract AC04-76DP03533. 7p. (CONF-800918—2). NTIS, PC A02/MF A01.

From International solvent extraction conference; Liege, Belgium (6 Sep 1980).

Americium recovery and purification development at Rocky Flats involves the testing of a combined anion exchange - bidentate organophosphorus liquid - liquid extraction or extraction chromatography process for separating americium from molten salt extraction residues. Laboratory-scale and preliminary pilot-plant results have shown that americium can be effectively recovered and purified from impurity elements such as aluminum, calcium, magnesium, plutonium, potassium, sodium, and zinc. The purified americium oxide product from the liquid - liquid extraction process contained greater than 95% AmO_2 with less than 1% of any individual impurity element.

30279 (RHO-SA—123) **Cyclohexanone solvent extraction of $^{99}TcO_4$ from alkaline nuclear waste solutions.** Schulz, W.W. (Rockwell International Corp., Richland, WA (USA). Energy Systems Group). Jan 1980. Contract AC06-77RL01030. 36p. (CONF-800918—4). NTIS, PC A03/MF A01.

From International solvent extraction conference; Liege, Belgium (6 Sep 1980).

Although the ^{99}Tc cyclohexanone solvent extraction process is still in the bench-scale development stage, the process appears well suited for engineering-scale removal of ^{99}Tc from alkaline Hanford waste solutions. The most pressing process development need is to resolve the phase disengaging problems encountered during water stripping operations. Stripping tests in pulse columns and/or centrifugal contactors are particularly needed to determine the magnitude of the phase disengaging problem in engineering-scale equipment and to find suitable remedies. 5 figures, 7 tables.

30280 (UCRL—84356) **Critique of rationale for transmutation of nuclear waste.** Smith, C.F.; Cohen, J.J. (California Univ., Livermore (USA). Lawrence Livermore National Lab.). Jul 1980. Contract W-7405-ENG-48. 11p. (CONF-800743—3). NTIS, PC A02/MF A01.

From International conference on nuclear waste transmutation; Austin, TX, USA (22 Jul 1980).

It has been suggested that nuclear transmutation could be used in the elimination or reduction of hazards from radioactive wastes. The rationale for this suggestion is the subject of this paper. The objectives of partitioning-transmutation are described. The benefits are evaluated. The author concludes that transmutation would appear at best to offer the opportunity of reducing an already low risk. This would not seem to be justifiable considering the cost. If non-radiological risks are considered, there is a negative total benefit. (DC)

30281 **Vitrification of actual high-level waste from light water reactor fuel.** Bjorklund, W.J.; Hanson, M.S. (Battell Pacific Northwest Lab., Richland, WA). pp 396-401 of Proceedings of the 27th conference on remote systems technology. Wallin, D.R. (ed.). La Grange Park, IL; American Nuclear Society, Inc. (1980).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

The high-level waste from the processing of 1.5 MT of spent light water reactor fuel has been successfully concentrated, dried, and converted to a vitreous product consisting of 94 l of glass contained in two stainless-steel canisters. The spray-calcination process coupled to the in-canister vitrification process as developed at Pacific Northwest Laboratory was used to solidify the waste. An effluent system consisting of a variety of condensation and scrubbing steps gave more than adequate cleanup to the process off-gas before it was released to the atmosphere.

30282 Process for disposal of aqueous solutions containing radioactive isotopes. Colombo, P.; Neilson, R.M. Jr.; Becker, W.W. (to Dept. of Energy). US Patent 4,174,293. 13 Nov 1979. Filed date 12 Oct 1977. 8p.
PAT-APPL-841,410.

A process for disposing of radioactive aqueous waste solution in which the waste solution is utilized as the water of hydration to hydrate densified powdered portland cement in a leakproof container is described. The waste solution is dispersed without mechanical inter-mixing in situ in the bulk cement. Thereafter the hydrated cement body is impregnated with a mixture of a monomer and polymerization catalyst to form polymer throughout the cement body. The entire process is carried out while the temperature of the components during the process is maintained at a temperature below 99°C. The container containing the solid polymerimpregnated body is thereafter stored at a radioactive waste storage dump such as an underground storage dump.

30283 Method for calcining nuclear waste solutions containing zirconium and halides. Newby, B.J. (to Dept. of Energy). US Patent 4,164,479. 14 Aug 1979. Filed date 12 Jan 1978. 6p.
PAT-APPL-868,953.

A reduction in the quantity of gelatinous solids which are formed in aqueous zirconium-fluoride nuclear reprocessing waste solutions by calcium nitrate added to suppress halide volatility during calcination of the solution while further suppressing chloride volatility is achieved by increasing the aluminum to fluoride mole ratio in the waste solution prior to adding the calcium nitrate.

30284 Separation of iodine from mercury containing scrubbing solutions. Burger, L.L.; Scheele, R.D. (to Dept. of Energy). US Patent 4,162,206. 24 Jul 1979. Filed date 16 Nov 1978. 4p.
PAT-APPL-961,174.

Radioactive iodines can be recovered from a nitric acid scrub solution containing mercuric nitrate by passing a current through the scrub solution to react the iodine with the mercuric nitrate to form mercuric iodate which precipitates out. The mercuric iodate can then be reacted to recover the radioiodine for further processing into a form suitable for long-term storage and to recover the mercury for recycling.

30285 Method for recovering palladium and technetium values from nuclear fuel reprocessing waste solutions. Horwitz, E.P.; Delphin, W.H. (to Dept. of Energy). US Patent 4,162,231. 24 Jul 1979. Filed date 28 Dec 1977. 4p.
PAT-APPL-865,347.

A method is described for recovering palladium and technetium values from nuclear fuel reprocessing waste solutions containing these and other values by contacting the waste solution with an extractant of tricaprylmethylammonium nitrate in an inert hydrocarbon diluent which extracts the palladium and technetium values from the waste solution. The palladium and technetium values are recovered from the extractant and from any other coextracted values with a strong nitric acid strip solution.

30286 Method of immobilizing carbon dioxide from gas streams. Holladay, D.W.; Haag, G.L. (to Dept. of Energy). US Patent 4,162,298. 24 Jul 1979. Filed date 9 Aug 1978. 10p.
PAT-APPL-932,152.

This invention comprises a method for rapidly and continuously immobilizing carbon dioxide contained in various industrial off-gas streams, the carbon dioxide being immobilized as dry, stable, and substantially water-insoluble particulates. Briefly, the method comprises passing the gas stream through a fixed or fluidized bed of hydrated barium hydroxide to remove and immobilize the carbon dioxide by converting the bed to barium carbonate. The method has several important advantages: it can be conducted effectively at ambient temperature; it provides a very rapid reaction rate over a wide range of carbon dioxide concentrations; it provides high decontamination factors; and it has a high capacity for carbon dioxide. The invention is especially well suited for the removal of radioactive carbon dioxide from off-gases generated by nuclear-fuel reprocessing facilities and nuclear power plants.

30287 Method for the recovery of actinide elements from nuclear reactor waste. Horwitz, E.P.; Delphin, W.H.; Mason, G.W. (to Dept. of Energy). US Patent 4,162,230. 24 Jul 1979. Filed date 28 Dec 1977. 10p.
PAT-APPL-865,346.

A process is described for partitioning and recovering actinide values from acidic waste solutions resulting from reprocessing of irradiated nuclear fuels by adding hydroxylammonium nitrate and hydrazine to the waste solution to adjust the valence of the neptunium and plutonium values in the solution to the +4 oxidation state, thus forming a feed solution and contacting the feed solution with an extractant of dihexoxyethyl phosphoric acid in an organic diluent whereby the actinide values, most of the rare earth values and some fission product values are taken up by the extractant. Separation is achieved by contacting the loaded extractant with two aqueous strip solutions, a nitric acid solution to selectively strip the americium, curium and rare earth values and an oxalate and oxalic acid or trimethylammonium hydrogen oxalate to selectively strip the neptunium, plutonium and fission product values. Uranium values remain in the extractant and may be recovered with a phosphoric acid strip. The neptunium and plutonium values are recovered from the oxalate by adding sufficient nitric acid to destroy the complexing ability of the oxalate, forming a second feed, and contacting the second feed with a second extractant of tricaprylmethylammonium nitrate in an inert diluent whereby the neptunium and plutonium values are selectively extracted. The values are recovered from the extractant with formic acid.

30288 Operation of a prototype alpha solid waste incinerator. Hootman, H.E.; Trapp, D.J.; Warren, J.H.; Dworjanyn, L.O. (E.I. duPont de Nemours and Co., Aiken, SC). *Trans. Am. Nucl. Soc.;* **33**: 947-948(1979). (CONF-791103—).
From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30289 Demonstration of radioactive sludge removal from SRP storage tank. Elder, H.H. (E.I. duPonte de Nemours and Co., Aiken, SC). *Trans. Am. Nucl. Soc.;* **33**: 939-940(1979). (CONF-791103—).
From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30290 Equipment for collecting sludge samples from Savannah River Plant waste tanks. Allen, B.M. Jr. (E.I. duPonte de Nemours and Co., Aiken, SC). *Trans. Am. Nucl. Soc.;* **33**: 941-942(1979). (CONF-791103—).
From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30291 Remote experimental facility to solidify SRP high-heat waste. Galloway, R.M.; Plodinec, M.J.; Wilhite, E.L.; Chismar, P.H. (E.I. duPonte de Nemours and Co., Aiken, SC). *Trans. Am. Nucl. Soc.;* **33**: 942-943(1979). (CONF-791103—).
From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30292 Vitrification of actual high-level waste from LWR fuel. Bjorklund, W.J.; Hanson, M.S. (Battelle Pacific Northwest Labs., Richland, WA). *Trans. Am. Nucl. Soc.;* **33**: 943-944(1979). (CONF-791103—).
From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30293 Radioactive waste incineration studies at the Los Alamos Scientific Laboratory. Borduin, L.C.; Draper, W.E.; Koenig, R.A.; Newmyer, J.M. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* **33**: 946-947(1979). (CONF-791103—).
From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30294 Background on leach testing of solifified radioactive wastes. Mendel, J.E. (Batelle Pacific Northwest Labs., Richland, WA). *Trans. Am. Nucl. Soc.;* **33**: 203(1979). (CONF-791103—).
From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

WASTE DISPOSAL AND STORAGE

REFER ALSO TO CITATION(S) 30267, 30322, 30326, 30328, 30337, 30562, 31144, 31151, 31245

30295 (CONF-800607—80) **Equipment designs for the spent LWR fuel dry storage demonstration.** Steffen, R.J.; Kurasch, D.H.; Hardin, R.T.; Schmitten, P.F. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Advanced Energy Systems Div.). 1980. Contract AC08-76NV00597. 41p. NTIS, PC A03/MF A01.
From American Nuclear Society annual meeting; Las Vegas, NV, USA (8 Jun 1980).

In conjunction with the Spent Fuel Handling and Packaging Program (SFHPP) equipment has been designed, fabricated and successfully utilized to demonstrate the packaging and interim dry storage of spent LWR fuel. Surface and near surface storage configurations containing PWR fuel assemblies are currently on test and generating baseline data. Specific areas of hardware design focused upon include storage cell components and the support related equip-

ment associated with encapsulation, leak testing, lag storage, and emplacement operations.

30296 (CONF-800918—3) **Removal of actinides from nuclear reprocessing wastes: a pilot plant study using non-radioactive simulants.** Maxey, H.R.; McIsaac, L.D.; Chamberlain, D.B.; McManus, G.J. (Exxon Nuclear Idaho Co., Inc., Idaho Falls (USA)). 1980. Contract AC07-76ID01570. 11p. NTIS, PC A02/MF A01.

From International solvent extraction conference; Liege, Belgium (6 Sep 1980).

Nuclear fuel reprocessing wastes generated at the ICPP contain small amounts of actinides, primarily Pu and Am. Removal of these actinides reduces the long term storage hazards of the waste. The development of a flowsheet to remove trivalent actinides is discussed in this paper. Pilot plant studies used actinide simulants. As a result of these studies, the Height of a Transfer Unit (HTU) was selected as the better measure of pulse column separation efficiency.

30297 (DOE/SR-WM—79-2) **Hydrology of buried crystalline rock at Savannah River Plant near Aiken, South Carolina.** Marine, I.W. (Department of Energy, Aiken, SC (USA). Savannah River Operations Office). Oct 1979. Contract AC09-76SR00001. 76p. NTIS, PC A05/MF A01.

The purpose of this report is to present the results of hydrologic investigations that were made on buried crystalline rock at the Savannah River Plant in connection with an investigation of the feasibility of storing high-level radioactive waste in artificially excavated chambers in the rock. The methods pursued in this investigation may be applicable to other investigations of low permeability metamorphic and igneous rocks. Fractures occurring in single boreholes were investigated by core inspection, geophysical logs, packer tests, and in-hole tracer tests. The correlation of fractures between holes was based on the rapidity of water level response to hydraulic activities in nearby wells and on an in-hole tracer test conducted in one boring while a nearby boring was being pumped. Values for hydraulic conductivity and other hydraulic parameters were determined from laboratory tests, packer tests, pumping tests, a two-well tracer test, and a numerical model that duplicated the results of a year-long pumping test. Dispersivity of the fractured crystalline rock was determined using a two-well tracer test. Water geochemistry and isotropic composition were evaluated. The age of the water was determined to be about 840,000 years. The average velocity of regional flow in crystalline rock is about 0.2 ft/y.

30298 (DP—1533) **Earthquake related displacement fields near underground facilities.** Pratt, H.R.; Zandt, G.; Bouchon, M. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Apr 1979. Contract AC09-76SR00001. 70p. NTIS, PC A04/MF A01.

Relative displacements of rock masses are evaluated in terms of geological evidence, seismological evidence, data from simulation experiments, and analytical predictive models. Numerical models have been developed to determine displacement fields as a function of depth, distance, and azimuth from an earthquake source. Computer calculations for several types of faults indicate that displacements decrease rapidly with distance from the fault, but that displacements can either increase or decrease as a function of depth depending on the type and geometry of the fault. For long shallow vertical strike-slip faults the displacement decreases markedly with depth. For square strike slip faults and for dip slip faults displacement does not decrease as markedly with depth. Geologic structure, material properties, and depth affect the seismic source spectrum. Amplification of the high frequencies of shear waves is larger by a factor of about 2 for layered geologic models than for an elastic half space.

30299 (IDO—10074(Rev.1)) **Criteria for packaging transuranic waste for receipt at the Idaho National Engineering Laboratory radioactive waste management complex offsite generated waste.** Anderson, B.C. (Idaho National Engineering Lab., Idaho Falls (USA)). Apr 1980. Contract AC07-76ID01570. 45p. NTIS, PC A03/MF A01.

This document delineates the packaging criteria requirements for storage of transuranic radioactive waste (> 10 nCi/g) at the Idaho National Engineering Laboratory. The Department of Energy, Idaho Operation Office (DOE-ID) will only accept transuranic waste from an offsite DOE location after an agreement has been reached between DOE-ID and the cognizant DOE field office. Several memoranda of agreements are currently in effect. The detailed criteria in these previously approved memoranda of agreements are superseded by the criteria in this document. Any deviations by the waste generator from the criteria stated herein must have prior approval of DOE-ID. In addition, DOE-ID will notify waste generators of any changes to the criteria prior to implementation.

30300 (LA—8339-PR) **Laboratory studies of radionuclide distributions between selected groundwaters and geologic media. Progress report, January 1-March 31, 1980.** Erdal, B.R. (comp.). (Los Alamos Scientific Lab., NM (USA)). May 1980. Contract W-7405-ENG-36. 55p. NTIS, PC A04/MF A01.

This report covers the technical activities on Waste-Rock Interactions and Technology (WRIT) contracts B-A2377-A-K and 78996-A-K to the Los Alamos Scientific Laboratory. Much of the activity during the second quarter of FY-80 involved those sorption studies needed to extend the current data base for tuff, to continue studies of sorption isotherms, to continue chemical analysis and characterization techniques, to continue studies using the microautoradiographic technique, and to continue measurements of migration rates in crushed and fractured materials. Finally, preparation of status reports has involved appreciable effort.

30301 (LBL—8313) **Instrument evaluation, calibration, and installation for the heater experiments at Stripa.** Schrauf, T.; Pratt, H.; Simonson, E.; Hustrulid, W.; Nelson, P.; DuBois, A.; Binnall, E.; Haught, R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.; Terra Tek, Inc., Salt Lake City, UT (USA)). Dec 1979. Contract W-7405-ENG-48. 187p. (SAC—25). NTIS, PC A09/MF A01.

Borehole instrumentation for the measurement of temperature, displacement, and stress was evaluated, modified, calibrated, and installed in an underground site at Stripa, Sweden where experiments are currently underway to investigate the suitability of granite as a storage medium for nuclear waste. Three arrays of borehole instrumentation measure the thermomechanical effects caused by electrical heaters which simulate the thermal output of canisters of radioactive waste. Because most rock mechanics investigations are carried out at modest temperatures, a sustained operating temperature as high as 200°C was an unusual and most important criterion governing the instrumentation program. Extensive laboratory experiments were conducted to determine the effect of high temperature on instrument behavior and also to develop calibration and data-reduction procedures. The rod extensometers were tested for anchor creep, the selection of a suitable high-temperature pressurizing fluid, and the thermal stability of the grout. Four temperature corrections are incorporated into the data reduction of the USBM borehole deformation measurement: the bridge voltage offset correction, the change in calibration factor induced by temperature, and the thermal expansion of the gage and of the rock. The vibrating wire gages were calibrated in the laboratory by loading gages installed in a granite block at pressures up to 13 MPa and at temperatures ranging from 20° to 200°C. Both the slope and offset of the response equation are corrected for temperature effects. Most thermocouples were calibrated in an oven at the field site. Thermocouples were emplaced with individual gages and into holes backfilled with sand or grout.

30302 (LBL—9392) **I. Some results from a field investigation of thermo-mechanical loading of a rock mass when heaters are emplaced in the rock. II. The application of field data from heater experiments conducted at Stripa, Sweden to parameters for repository design. SAC-26.** Hood, M.; Carlsson, H.; Nelson, P.H. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1979. Contract W-7405-ENG-48. 47p. NTIS, PC A03/MF A01.

Separate abstracts were prepared for Parts I and II.

30303 (LBL—9392, pp 1-23) **I. Some results from a field investigation of thermo-mechanical loading of a rock mass when heaters are emplaced in the rock.** Hood, M. (Univ. of California, Berkeley). Jul 1979.

In I. Some results from a field investigation of thermo-mechanical loading of a rock mass when heaters are emplaced in the rock. II. The application of field data from heater experiments conducted at Stripa, Sweden to parameters for repository design. SAC-26.

Results are presented of a field experiment to monitor the response of a rock mass to thermomechanical loading from electrically heated canisters emplaced in the rock at a depth of 340 m. Measurements made to date of temperature, displacement, and stress fields indicate that heat is transferred through the rock mainly by conduction; discontinuities within the rock mass have a minimal effect on the heat flow. Displacements within the rock from thermal expansion are shown to be much less than those predicted by linear thermoelastic theory. A plausible, though not complete, reason for these reduced displacements is the absorption of the initial rock expansions into discontinuities within the rock mass. Difficulties have been experienced in obtaining reliable stress measurement data using borehole deformation gauges to monitor changes in rock stress. Some data have been obtained and are being analyzed. Rock decrepitation in the heater boreholes is discussed.

30304 (LBL—9392, pp 24-39) **II. Application of field data from heater experiments conducted at Stripa, Sweden, to parameters for repository design.** Hood, M.; Carlsson, H.; Nelson, P.H. (Univ. of California, Berkeley). Jul 1979.

In I. Some results from a field investigation of thermo-mechanical loading of a rock mass when heaters are emplaced in the rock. II. The application of field data from heater experiments conducted at Stripa, Sweden to parameters for repository design. SAC-26.

Current experiments are designed to yield information about both the near-field and the far-field effects of thermomechanical loading of an in-situ, granitic rock mass. Electrically heated canisters, constructed to represent high-level radioactive waste canisters, are emplaced in boreholes from excavations some 340 m below the surface. Thermally induced spalling along the heater borehole wall, a near-field effect, has been monitored and two types of spalling, one serious and one not serious, have been identified. A suggested failure criterion for the serious type of spalling is $\sigma/\text{sub max}/ \geq C_0$ (where $\sigma/\text{sub max}/$ is the maximum induced compressive stress at the borehole wall and C_0 is the uniaxial compressive strength of the rock). In one of these experiments this criterion was exceeded, and gross failure at the wall occurred when the equivalent power to the heater was increased beyond 5 kW. The far-field effects of the applied loading are investigated by measuring the temperature, displacement, and stress fields and then comparing the results with predictions which were made based on linear thermoelastic theory. The results show that the dominant mode of heat transfer through the rock is by conduction and, therefore, that predictions of the temperature field are made readily using simple calculations. However, displacements and stresses within the rock mass are measured to be only one-half or less of the values predicted. Two reasons for this major discrepancy are suggested. Work to verify this result is in progress.

30305 (ONWI—9(4)) **Technical progress report for the quarter July 1-September 30, 1979.** (Battelle Columbus Labs., OH (USA)). 1979. Contract AC06-76RL01830. 394p. NTIS, PC A17/MF A01.

This report describes the technical accomplishments on the commercial nuclear waste management programs under the direction of the Office of Nuclear Waste Isolation (ONWI). The ONWI program is designed to provide all of the technology and engineering design bases for a waste repository to isolate nuclear waste safely, with protection to the environment.

30306 (ORNL—5617) **Autoradiographic study of actinide sorption on climax stock granite.** Beall, G.W.; O'Kelley, G.D.; Allard, B. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 30p. NTIS, PC A03/MF A01.

An autoradiographic technique that employed an arrangement for placing in firm contact Polaroid sheet film, a scintillator screen, and the radioactive face of a specimen was applied to a study of the sorption of americium, neptunium, plutonium, and uranium on Climax Stock granite under varying conditions of pH and Eh. Qualitative agreement was found between the sorption of americium on crushed, pure minerals and on the minerals comprising the specimen of Climax Stock granite. The observations also supported a mechanism for reduction of Np(V) to Np(IV) and Pu(VI) to Pu(IV) by Fe(II)-containing minerals. There was no evidence for reduction of U(VI) by the Fe(II)-containing minerals, although the uranium, assumed to be present as UO_2^{2+}, appeared to be the only actinide species to exhibit sorption by a simple, cation-exchange mechanism at particular mineral sites. Some implications of these results for nuclear waste isolation are discussed briefly.

30307 (PNL-SA—8571(Vol.1)) **Waste isolation safety assessment program. Task 4. Third contractor information meeting.** (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jun 1980. Contract AC06-76RL01830. 558p. (CONF-7910160—(Vol.1)). NTIS, PC A24/MF A01.

From 3. contractor information meeting on waste isolation safety assessment program task 4; Seattle, WA, USA (14 Oct 1979).

The Contractor Information Meeting (October 14 to 17, 1979) was part of the FY-1979 effort of Task 4 of the Waste Isolation Safety Assessment Program (WISAP): Sorption/Desorption Analysis. The objectives of this task are to: evaluate sorption/desorption measurement methods and develop a standardized measurement procedure; produce a generic data bank of nuclide-geologic interactions using a wide variety of geologic media and groundwaters; perform statistical analysis and synthesis of these data; perform validation studies to compare short-term laboratory studies to long-term in situ behavior; develop a fundamental understanding of sorption/desorption processes; produce x-ray and gamma-emitting isotopes suitable for the study of actinides at tracer concentrations; disseminate resulting information to the international technical community; and provide input data support for repository safety assessment. Conference participants included those subcontracted to WISAP Task 4, representatives and independent subcontractors to the Office of Nuclear Waste Isolation, representatives from other waste disposal programs, and experts in the area of waste/geologic media interaction. Since the meeting, WISAP has been divided into two programs: Assessment of Effectiveness of Geologic Isolation Systems (AEGIS) (modeling efforts) and Waste/Rock Interactions Technology (WRIT) (experimental work). The WRIT program encompasses the work conducted under Task 4. This report contains the information presented at the Task 4, Third Contractor Information Meeting. Technical Reports from the subcontractors, as well as Pacific Northwest Laboratory (PNL), are provided along with transcripts of the question-and-answer sessions. The agenda and abstracts of the presentations are also included. Appendix A is a list of the participants. Appendix B gives an overview of the WRIT program and details the WRIT work breakdown structure for 1980.

30308 (RHO-BWI-LD—19) **Technical requirements for qualification of A potential nuclear waste repository site in basalt.** Johnson, R.E.; Deju, R.A. (Rockwell International Corp., Palo Alto, CA (USA). Energy Systems Group). Sep 1979. Contract AC06-77RL01030. 27p. NTIS, PC A03/MF A01.

A site identification study has been conducted to identify and categorize a number of candidate sites that appear to be suitable for the location of a repository for radioactive waste on the Hanford Site. Three objectives were defined as a basis for the selection of guidelines for screening. These were: (1) maximize public health and safety; (2) minimize adverse environmental and socioeconomic impact; and (3) minimize system costs. For each objective, appropriate considerations were identified; a guideline for which would be the delineation of progressively smaller siting areas and sites that may be suitable for locating a repository. This document is designed to be used as the reference framework for guiding the qualification of identified sites in lieu of formal NRC-issued criteria. As such, it will serve as a framework for guiding our research and development effort. A site will be considered qualified when, having been characterized in detail, it is demonstrated to meet these requirements and thus can be offered for formal licensing by the NRC.

30309 (RHO-BWI-SA—49) **Basalt Waste Isolation Project borehole plugging studies: an overview.** Smith, M.J.; McCarel,, S.C. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). 1980. Contract AC06-77RL01030. 14p. (CONF-800527—7). NTIS, PC A02/MF A01.

From International BHP symposium; Columbus, OH, USA (7 May 1980).

The objective of the Basalt Waste Isolation Project (BWIP) is to establish the feasibility of constructing a geologic repository for commercial high-level nuclear waste in the basalt flows within the Columbia Plateau and to provide the technology needed for design and construction of such a facility. The success of a repository located in basalt is dependent upon the ability to seal the facility at the end of the operational period. Therefore, a borehole plugging study is being conducted by the engineered barriers group of the BWIP in order to develop,test, and demonstrate materials, equipment, and techniques for plugging the various man-made openings (boreholes, shafts, and tunnels) in and around the repository. These plugs are intended to severely restrict groundwater transport of toxic materials by both chemical and physical retardation. Verification of engineered plug system designs is accomplished through a proposed series of field tests and demonstrations.

30310 (RHO-BWI-SA—50) **Sealing a nuclear waste repository in Columbia River basalt: preliminary results.** Hodges, F.N.; O'Rourke, J.E.; Anttonen, G.J. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations; Woodward-Clyde Consultants, San Francisco, CA (USA)). 1980. Contract AC06-77RL01030. 21p. (CONF-800527—6). NTIS, PC A02/MF A01.

From International BHP symposium; Columbus, OH, USA (7 May 1980).

The long containment time required of repositories for nuclear waste (10^4 to 10^6 years) requires that materials used for repository seals be stable in the geologic environment of the repository and of proven longevity. A list of candidate materials for sealing a repository in Columbia River basalts has been prepared and refined through laboratory testing. The most feasible techniques for emplacing preferred plug materials have been identified and the resultant plugs have been evaluated on the basis of design functions. Preconceptual designs for tunnel, shaft, and borehole seals consist of multiple zone plugs with each zone fulfilling one or more design functions. Zones of disturbed rock around tunnels and shafts, resulting from excavation and subsequent stress release, are zones of higher permeability and of possible fluid migration. In preliminary designs the disturbed zones are blocked by cut-off collars filled with low permeability materials.

30311 (RHO-C—39) **Comparison of the microstructure of Hanford Type II concrete structures and test specimens.** Daniel, J.L.; Buck, A.O. (Battelle Pacific Northwest Labs., Richland, WA (USA); Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations; Corps of Engineers, Vicksburg, MS (USA). Waterways Exeriment Station). Apr 1980. Contract AC06-77RL01030. 96p. NTIS, PC A05/MF A01.

High-level radioactive waste from the current waste management operation at Hanford is stored in underground reinforced concrete tanks with a steel liner on the sides and bottom. The removal of pumpable liquid results in a moist salt-cake of sodium salts that is relatively immobile compared to its original liquid state. Additional immobilization and isolation techniques are being studied to further improve waste isolation and containment. Retrieval of the waste and permanent disposal will be deferred until a permanent disposal mode and location is selected. The integrity of the storage

tanks is of critical importance during this interim period. Technical studies and laboratory tests have been performed to determine the effect of the stored waste's temperatures and chemistry on the reinforced concrete's strength and elastic properties. However, relatively little attention has been given to studying or predicting very long-term behavior based on short-term specimen examination. This report describes the results of the first phase of a laboratory program for which the ultimate goal is the ability to predict the probable condition of Hanford Type II concrete structures after 100 years of more of lifetime. The purpose of this phase was the evaluation of the microstructure of several existing test and field samples of Hanford concrete, and to correlate microstructural data with the physical test measurements on hand from other programs and tasks.

30312 (RHO-SA—108) **Structural evaluations of existing underground reinforced concrete tanks for radioactive waste storage.** Vollert, F.R. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). Oct 1979. Contract AC06-77RL01030. 40p. (CONF-791196—1). NTIS, PC A03/MF A01.

From Symposium on evaluation of existing concrete structures; Washington, DC, USA (1 Nov 1979).

Structural integrity evaluations are being conducted for underground, steel-lined reinforced concrete tanks for storing radioactive wastes. The tanks sustain large soil overburden loads and elevated temperatures from the waste for long time periods. The evaluations include laboratory experiments to determine the long-term effects of elevated temperatures on the elastic properties of concrete, and to estimate the effect of the waste chemicals on concrete durability. Available concrete samples from the tanks were also tested to determine the quality of the concrete in the tanks and for comparison with the laboratory data. Finite element, nonlinear, time-dependent analyses are performed to show the thermal creep, cracking, and stresses occurring in the concrete tanks due to the service conditions. Ultimate load analyses are made to assess the safety margin in the tanks. Finally, seismic analyses of a tank in the stressed condition due to the soil and thermal loadings were conducted to determine that the structure has sufficient reserve capacity to withstand 0.25 g earthquake accelerations.

30313 (SAND—79-2245) **Strategy for assessing the technical, environmental, and engineering feasibility of subseabed disposal.** Anderson, D.R.; Talbert, D.M.; Reese, D.; Boyer, D.G.; Herrmann, H.; Kelly, J. (Sandia National Labs., Albuquerque, NM (USA); Harvard Univ., Cambridge, MA (USA); Department of Energy, Washington, DC (USA); New Hampshire Univ., Durham (USA)). Jul 1980. Contract AC04-76DP00789. 26p. NTIS, PC A03/MF A01.

This report presents the strategy and management techniques used in the development of the US Subseabed Disposal Program (SDP) for possible disposal of both high-level waste and spent fuel. These have been developed through joint efforts of the Department of Energy (DOE), Division of Waste Isolation, the Sandia Technical Program Manager, the Technical Program Coordinators, the Advisory Group, and the Principal Investigators. Three subsections of this paper address the various components which make up the SDP strategy and management techniques. The first section summarizes the US DOE high-level waste and spent-fuel disposal program and the position that the SDP occupies within that program. The second section, the Subseabed Program Plan, addresses the technical and administrative tools which are employed to facilitate the day-to-day operation of the SDP. The third section addresses the current studies and future plans for addressing the legal, political, and international uncertainties that must be resolved before the SDP reaches the final engineering phases.

30314 (SAND—80-0307C) **Sediment mechanical response due to emplacement of a waste canister.** Karnes, C.H.; Dawson, P.R.; Silva, A.J.; Brown, W.T. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 11p. (CONF-800921—3). NTIS, PC A02/MF A01.

From IEEE/Oceans '80 conference; Seattle, WA, USA (8 Sep 1980).

Preliminary studies have been conducted to determine the interaction between a waste canister and seabed sediment during and after emplacement. Empirical and approximate methods for determining the depth reached by a freefall penetrator indicate that a boosted penetrator emplacement method may be necessary. Hole closure is necessary, but has not been verified because calculations and laboratory experiments show sensitivity to boundary conditions which control the degree of dynamic hole closure. Laboratory studies show that closure will take place by creep deformation but closure times in seabed environments are uncertain. For assumed thermomechanical properties of sediments, it is shown that a heat generating waste canister will probably not move a significant distance during the heat generation period.

30315 (SAND—80-1407C) **Geochemical studies supporting the US subseabed disposal program.** Erickson, K.L.; Seyfried, W.E.; Heath, G.R.; Krumhansl, J.L.; Bowen, V.T. (Sandia National Labs., Albuquerque, NM (USA); Minnesota Univ., Minneapolis (USA); Oregon State Univ., Corvallis (USA); Woods Hole Oceanographic Institution, MA (USA)). 1980. Contract AC04-76DP00789. 18p. NTIS, PC A02/MF A01.

The important chemical phenomena associated with emplacing high-level radioactive waste in subseabed geologic formations are being identified and experimentally investigated. Studies of processes occuring in the hydrothermal environment near the canister have focused on sediment-seawater interactions at elevated temperatures and pressures and the resulting potential effects on canister, wasteform, and radionuclide source term. Significant changes in oxidation potential and pH have been related to variations in temperature and mineralogy. Investigation of phenomena occurring in the sediment outside of the hydrothermal environment have focused on actinide solution chemistry, sorption phenomena, and radionuclide diffusion rates. Data for several radionuclides and sediment types are being used to compare predicted and experimental results from diffusion experiments. Studies of processes occurring near the sediment-seawater interface have emphasized establishing a data base for evaluating the geochemical, physical, biological, and fluid-mechanical mechanisms determining radionuclide fluxes across the interface.

30316 (SAND—80-1592C) **Geomechanics activities conducted at Sandia National Laboratories in support of the waste isolation pilot plant.** Krieg, R.D.; Hunter, T.O. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 16p. (CONF-800751—1). NTIS, PC A02/MF A01.

From Workshop on thermomechanical-hydrochemical modeling for hardrock waste repository; Bereley, CA, USA (29 Jul 1980).

The geotechnical characterization associated with the development of the WIPP includes: (a) studies of the hydrologic flow system in surrounding aquifer systems, and (b) studies of thermal-structural interaction between the repository and the rock formation. The former is summarized in a companion paper. The latter, to be discussed here, includes the development and verification of methods to evaluate the response of the host rock to both ambient conditions upon excavation and the enhanced deformations anticipated with heat-producing wastes. This program includes development and application of analytical models, laboratory materials testing, and in situ testing. The thermostructural analysis capability for the WIPP repository in halite is advancing rapidly. The creep characteristics of halite, while not completely established for short-time or primary creep behavior, seems well established for long-time behavior. There are several operational computer programs which have demonstrated a capability to work these problems. They are presently being compared with the second in a series of benchmark problems. A single, but important concern with the codes is the long running times and therefore high cost of running meaningful problems. Three-dimensional calculations have not been considered at this time for that reason. An understanding of the role of various stratigraphic details is being developed as more calculations are made. This experience base will be valuable in narrowing alternatives in design work. A detailed correlation of the codes with field data is just beginning. This correlation and the characterization of primary creep in halite are the two areas receiving the most research emphasis at this time.

30317 (UCRL—52747) **New developments in measurement technology relevant to the studies of deep geological repositories in domed salt and basalt.** Ramirez, A.L.; Mao, N.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 May 1980. Contract W-7405-ENG-48. 73p. NTIS, PC A04/MF A01.

This report briefly describes recent geophysical and geotechnical instrumentation developments relevant to the studies of deep geologic repositories. Special emphasis has been placed on techniques that appear to minimize measurement problems associated with repositories constructed in basalt or domed salt. Included in the listing are existing measurement capabilities and deficiencies that have been identified by a few authors and instrumentation workshops that have assessed the capabilities of existing instrumentation with respect to repository applications. These deficiencies have been compared with the reported advantages and limitations of the new developments described. Based on these comparisons, areas that merit further research and development have been identified. The report is based on a thorough literature review and on discussions with several instrumentation specialists involved in instrumentation development.

30318 **Retrieval methods and equipment for WIPP high-level waste experiment area.** Dennis, A.W.; Stinebaugh, R.E. (Sandia Labs., Albuquerque, NM). *Trans. Am. Nucl. Soc.*; **33**: 944-946(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30319 **Experimental procedure for proposed ANS standard on low-level waste leachability.** Neilson, R.M. Jr. (Brookhaven National

Lab., Upton, NY). *Trans. Am. Nucl. Soc.;* **33**: 203-205(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30320 Figure-of-merit determined from the ANS leachability standard. Godbee, H.W.; Compere, E.L. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **33**: 205-206(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30321 Interrelation of short-term leach tests and long-term leaching. Compere, E.L.; Godbee, H.W. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **33**: 207-208(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 30294, 30319, 30320, 30321, 30337, 31148

30322 (CONF-800304—11) **Migration of radionuclides following shallow land burial.** Sedlet, J.; Golchert, N.W. (Argonne National Lab., IL (USA)). 1980. Contract W-31-109-ENG-38. 5p. NTIS, PC A02/MF A01.

From 5. international congress of the International Radiation Protection Association; Jerusalem, Israel (8 Mar 1980).

A study of radionuclide migration was conducted at a facility used from 1944 to 1949 for the shallow land burial of radwaste produced during operations with two reactors and related nuclear research. It is situated in glacial drift 45 m thick. Underlying the drift is a generally level Silurian dolomite bedrock 60 m thick. The thickness of the drift decreases as the surface slopes downhill (north) until the dolomite reaches the surface and forms the bed of a river, 700 m to the north. This study was begun after tritiated water was detected in two picnic wells north of the facility, between the burial plot and the river. Surface and subsurface measurements indicate that tritium is migrating out of the burial site, but no other radionuclides have left the plot. The tritium concentrations decrease with distance from the plot. Tritium was found in the subsoil at all depths sampled, so the ground beneath and immediately around the plot contains tritium down to the dolomite aquifer. Time of travel of water from the burial plot to the nearest well is estimated to be 54 months. This would imply the peak concentration would reach the dolomite in about 35 years. By this time, 86% of the tritium would have disappeared by radioactive decay. The cyclical nature of the tritium content in the two wells implies that tritiated water is carried from the burial site by the spring rains when they recharge the groundwater supply.

30323 (DP-MS—80-3) **Identification of potential safety-related incidents applicable to a breeder fuel reprocessing plant.** Perkins, W.C. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1980. Contract AC09-76SR00001. 24p. (CONF-800901—3). NTIS, PC A02/MF A01.

From Symposium on intermediate range atmospheric transport processes and technology assessment; Gatlinburg, TN, USA (29 Sep 1980).

The current emphasis on safety in all phases of the nuclear fuel cycle requires that safety features be identified and included in designs of nuclear facilities at the earliest possible stage. A popular method for the early identification of these safety features is the Preliminary Hazards Analysis. An extension of this analysis is to illustrate the nature of a hazard by its effects in accident situations, that is, to identify what are called safety-related incidents. Some useful tools are described which have been used at the Savannah River Laboratory SRL, to make Preliminary Hazards Analyses as well as safety analyses of facilities for processing spent nuclear fuels from both power and production reactors. These tools have also been used in safety studies of waste handling operations at the Savannah River Plant. The tools are the SRL Incidents Data Bank and the What If meeting. The application of this methodology to a proposed facility which has breeder fuel reprocessing capability, the Hot Experimental Facility (HEF) is illustrated.

30324 (ORNL/TM—6986) **Actinide partitioning-transmutation program final report. VI. Short-term risk analysis of reprocessing, refabrication, and transportation: summary.** Fullwood, R.; Jackson, R. (Science Applications, Inc., Palo Alto, CA (USA)). Mar 1980. Contract W-7405-ENG-26. 69p. NTIS, PC A04/MF A01.

A Partitioning-Transmutation (PT) fuel cycle is being compared to a Reference cycle employing conventional fuel-material recovery methods. The PT cycle uses enhanced recovery methods so that most of the long-lived actinides are recycled to nuclear power plants and transmuted thereby reducing the waste toxicity. This report compares the two fuel cycles on the basis of the short-term radiological and nonradiological risks. The accidental radiological risk to the public is analyzed by estimating the probabilities of sets of accidents; the consequences are calculated using the risk, which is RAC code. Routine radiological risks to the public are estimated from the calculated release amounts, also using the CRAC code. Radiological occupational risks are determined from prior experience, projected standards, and estimates of accident risk. Nonradiological risks are calculated from the number of personnel involved, historical experience, and epidemiological studies. Result of this analysis is that the short-term risk of PT is 2.9 times greater than that of the Reference cycle, primarily due to the larger amount of industry. The nonradiological risk which is about 150 times greater than the radiological risk. If the radiological risk is consdered alone, the ratio of PT to Reference risk is 3, composed as follows: radiological operations affecting the public 5, radiological operations affecting the workers 1.7, and radiological accidents affecting the public 1.4, all in the order of decreasing risk. The absolute risk as estimated for the fuel cycle portions considered in this report is 0.91 fatality/GWe-year for the PT cycle and 0.34 fatality/GWe-year for the reference cycle; this compares with 1.5 for nuclear and 150 for coal. All of the risks assumed here are associated with the production of one billion watts of electricity (GWe) per year.

30325 (UCRL—52705) **Seismic evaluation of commercial plutonium fabrication plants in the United States.** Bernreuter, D.L.; Coats, D.W.; Murray, R.C.; Tokarz, F.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Oct 1979. Contract W-7405-ENG-48. 69p. NTIS, PC A04/MF A01.

This report is an overview of Lawrence Livermore National Laboratory's seismic assessment of six commercial plutonium fabrication plants licensed by the US Nuclear Regulatory Commission (NRC) before September 2, 1971. The seismic assessment generally has three parts: (1) documentation of the structural condition of each facility and its critical equipment; (2) characterization of the seismic hazard (i.e., determination of peak ground acceleration vs return period for each site); and (3) evaluation of seismic capacity to determine ground motion levels at which critical structures and equipment fail. The failure evaluation used structural capacities of median-centered strength characteristics of the as-built configurations from (1) and seismic hazard input from (2). Results of the assessment were partial input for an overall natural risks study by the NRC.

30326 Methods for predicting the effectiveness of uranium mill tailings covers. Cohen, B.L. (Argonne National Lab., IL (USA)). *Nucl. Instrum. Methods;* **164**: No. 3, 595-599(1 Sep 1979).

The theory for diffusion of radon through uranium mill tailings piles and covers placed over them is developed in a simple but reasonably accurate form. The results depend on a knowledge of diffusion constants. Methods for measuring these in a laboratory are considered and a much simpler method than those in use is developed and recommended.

REGULATIONS

ACCOUNTABILITY AND SAFEGUARDS

REFER ALSO TO CITATION(S) 30619, 30620, 30621, 30761, 30950, 30963

30327 (AGNS—35900-CONF-61) **On-line monitoring of plutonium in mixed uranium-plutonium solutions.** Hofstetter, K.J.; Rebagay, T.V.; Huff, G.A. (Allied-General Nuclear Services, Barnwell, SC (USA)). Mar 1980. Contract AC09-78ET35900. 17p. (CONF-800433—7). NTIS, PC A02/MF A01.

From 4. international conference on nuclear methods in environment and energy research; Columbia, MO, USA (14 Apr 1980).

The measurement of the total and isotopic plutonium concentrations in mixed uranium-plutonium solutions blended with highly radioactive fission product nuclides and other radionuclides (e.g., Cs-137 and Co-60) has been investigated at the Barnwell Nuclear Fuel Plant (BNFP). An on-line total and isotopic plutonium monitoring system is being tested for its ability to assay the plutonium abundances in solutions as might be found in the process streams of a light water reactor (LWR) spent fuel processing plant. The monitoring system is fully automated and designed to be maintained remotely. It is capable of near real-time inventory of plutonium in process streams and provides the basis for on-line computerized accounting of special nuclear materials.

30328 (BNL—28054) **Laser surveillance system for spent fuel.** Fiarman, S.; Zucker, M.S.; Bieber, A.M. Jr. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract AC02-76CH00016. 13p. (CONF-800655—29). NTIS, PC A02/MF A01.

From 21. annual meeting of the Institute of Nuclear Materials Management; Palm Beach, FL, USA (30 Jun 1980).

A laser surveillance system installed at spent fuel storage pools will provide the safeguard inspector with specific knowledge of spent fuel movement that cannot be obtained with current surveillance systems. The laser system will allow for the division of the pool's spent fuel inventory into two populations - those assemblies which have been moved and those which haven't - which is essential for maximizing the efficiency and effectiveness of the inspection effort. We have designed, constructed, and tested a laser system and have used it with a simulated BWR assembly. The reflected signal from the zircaloy rods depends on the position of the assembly, but in all cases is easily discernable from the reference scan of background with no assembly.

30329 (HEDL-SA—2070-FP) **Safeguarding on-line accountability data.** Carlson, R.L. (Hanford Engineering Development Lab., Richland, WA (USA)). Jun 1980. Contract AC14-76FF02170. 8p. (CONF-800655—25). NTIS, PC A02/MF A01.

From 21. annual meeting of the Institute of Nuclear Materials Management; Palm Beach, FL, USA (30 Jun 1980).

HEDL is developing a computerized accountability system that addresses the concerns of data access and data protection. The system utilizes a distributed processing network with transaction oriented software. Microprocessor controlled data accumulation stations are utilized which permit data editing to reduce errors, while maintaining several levels of backup protection. Software changes are allowed only after thorough review, protected by passwording, and are overchecked by audit. Protection against misuse by unauthorized individuals utilizes extensive physical security of the computer and the remote terminals. The positive identification devices and strict software control ensure that individuals cannot subvert the system without leaving an audit trail of their actions. This serves as a deterrent against malevolent acts by the authorized user.

30330 (HEDL-SA—2073-FP) **Cooperative testing of a positive personnel identifier.** O'Callaghan, P.B.; Grambihler, A.J.; Graham, D.K.; Bradley, R.G. (Hanford Engineering Development Lab., Richland, WA (USA); Sandia National Labs., Albuquerque, NM (USA)). Jun 1980. Contract AC14-76FF02170. 8p. (CONF-800655—27). NTIS, PC A02/MF A01.

From 21. annual meeting of the Institute of Nuclear Materials Management; Palm Beach, FL, USA (30 Jun 1980).

HEDL has a requirement to ensure the identification of remote computer terminal operators on a real-time nuclear inventory data base. The integrity of this data base depends on input from authorized individuals. Thus, a key to developing such a system is the ability to positively identify people attempting access to the system. Small scale tests of the Identimat 2000T hand geometry unit with an adjusting alogrithm have suggested a promising solution. To prove operational suitability, HEDL, in cooperation with Sandia Laboratories, has designed a large scale test of the Identimat 2000T. Data gathering on error rates, reliability, maintainability, and user acceptance will determine if the Identimat 2000T is suitable for the HEDL application. If proven acceptable, use of the Identimat 2000T can be broadened to many general applications where security information, locations and systems are required.

30331 (HEDL-SA—2099-FP) **Achieving higher count rates with EDX.** Lambert, M.C. (Hanford Engineering Development Lab., Richland, WA (USA)). 1980. Contract AC14-76FF02170. 23p. (CONF-800318—3). NTIS, PC A02/MF A01.

From Pittsburgh conference; Atlantic City, NJ, USA (9 Mar 1980).

An automated energy-dispersive x-ray spectrometer (EDX) was developed for the close-coupled analysis of mixed U, Pu oxide fuel pellets. (Close-coupled means the analytical glove box is closely adjacent to the production line.) The L α fluorescences of U and Pu were chosen. The advantages and disadvantages of the system are given. (DLC)

30332 (LA—8404-MS) **Channel coincidence counter: version 1.** Krick, M.S.; Menlove, H.O. (Los Alamos Scientific Lab., NM (USA)). Jun 1980. Contract W-7405-ENG-36. 22p. NTIS, PC A02/MF A01.

A thermal neutron coincidence counter has been designed for the assay of fast critical assembly fuel drawers and plutonium-bearing fuel rods. The principal feature of the detector is a 7-cm by 7-cm by 97-cm detector channel, which provides a uniform neutron detection efficiency of 16% along the central 40 cm of the channel. The electronics system is identical to that used for the High-Level Neutron Coincidence Counter.

30333 (LA-UR—80-1789) **Nondestructive measurements on spent fuel for the nuclear fuel cycle.** Cobb, D.D.; Phillips, J.R. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 13p. (CONF-800655—14). NTIS, PC A02/MF A01.

From 21. annual meeting of the Institute of Nuclear Materials Management; Palm Beach, FL, USA (30 Jun 1980).

Nondestructive measurements on spent fuel are being developed to meet safeguards and materials managment requirements at nuclear facilities. Spent-fuel measurement technology and its applications are reviewed.

30334 (LA-UR—80-1796) **Rapid fuel drawer scanner for fast critical assembly safeguards.** Pratt, J.C.; France, S.W.; Hsu, H.H.; Caldwell, J.T.; Hastings, R.D.; Shunk, E.R. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 15p. (CONF-800655—8). NTIS, PC A02/MF A01.

From 21. annual meeting of the Institute of Nuclear Materials Management; Palm Beach, FL, USA (30 Jun 1980).

An integrated scanning system incorporating highly efficient collimated neutron and high purity germanium gamma detectors with an on-line microprocessor has been developed to perform rapid inventorying of uranium and plutonium fuel drawers from fast critical assemblies. On-line least-squares fit procedures provide quantitative comparisons at a rate exceeding two drawers per minute. For plutonium-containing fuel, the neutron scan data can be related to the included ^{240}Pu isotopic mass; individual ^{239}Pu, ^{241}Pu, and ^{241}Am isotopic contents are obtained from simultaneous scans of the appropriate isolated gamma lines.

30335 (NBL—295) **Safeguards Analytical Laboratory Evaluation (SALE) 1979 annual report.** (Department of Energy, Argonne, IL (USA). New Brunswick Lab.). Jul 1980. 131p. NTIS, PC A07/MF A01.

The data in this report indicate that reliability of measurements is probably more closely associated with the methods of measurement employed by the laboratories than with any other factor. However, since other laboratories use, with success, the same methods that show some diversity in laboratory means with success, it must be concluded that factors relating to measurement control within a given laboratory may be responsible for inaccurate or imprecise results. The relatively small quantity of data reported for the analysis of plutonium-bearing materials does not permit an in-depth evaluation of measurement performance. The data demonstrate that random and systematic errors associated with uranium measurements are within acceptable limits and that measurement performance in the analysis of low enriched uranium can be considered as good to excellent. The measurement performance related to plutonium-bearing materials appears to be acceptable based on the limited data available. However, developmental activities designed to improve plutonium measurement technology should be expedited.

30336 (SAND—80-0706) **Workshop materials from the 2nd international training course on physical protection of nuclear facilities and materials, Module 13.** Martin, F.P. (ed.). (Sandia National Labs., Albuquerque, NM (USA)). Apr 1980. Contract AC04-76DP00789. 256p. NTIS, PC $16.50/MF $3.95.

This course is intended for representatives of countries where nuclear power is being developed and whose responsibilities include the preparation of regulation and the design and evaluation of physical protection systems. This is the second of two volumes; the first volume is SAND-79-1090. (DLC)

ADMINISTRATIVE AND REGULATORY

30337 (ORNL/TM—7262) **Operating safety requirements for the intermediate level liquid waste system.** (Oak Ridge National Lab., TN (USA)). Jul 1980. Contract W-7405-ENG-26. 38p. NTIS, PC A03/MF A01.

The operation of the Intermediate Level Liquid Waste (ILW) System, which is described in the Final Safety Analysis, consists of two types of operations, namely: (1) the operation of a tank farm which involves the storage and transportation through pipelines of various radioactive liquids; and (2) concentration of the radioactive liquids by evaporation including rejection of the decontaminated condensate to the Waste Treatment Plant and retention of the concentrate. The following safety requirements in regard to these operations are presented: safety limits and limiting control settings; limiting conditions for operation; and surveillance requirements. Staffing requirements, reporting requirements, and steps to be taken in the event of an abnormal occurrence are also described. (DC)

FUSION FUELS

PROCESSING

FABRICATION AND TESTING

30338 **Method for introduction of gases into microspheres.** Hendricks, C.D.; Koo, J.C.; Rosencwaig, A. US Patent Application 061,166. [nd]. 32p.

A method is described for producing small hollow glass spheres filled with a gas by introduction of the gas during formation of the hollow glass spheres. Hollow glass microspheres having a

diameter up to about 500μ with both thin walls (0.5 to 4/sub μ/) and thick walls (5 to 20/sub μ/) that contain various fill gases, such as Ar, Kr, Xe, Br, D, H_2, DT, He, N_2, Ne, CO_2, etc., in the interior thereof, can be produced by the diffusion of the fill gas or gases into the microsphere during the formation thereof from a liquid droplet of glass-form-forming solution. This is accomplished by filling at least a portion of the multiple-zone drop-furnace used in producing hollow microspheres with the gas or gases of interest, and then taking advantage of the high rate of gaseous diffusion of the fill gas through the wall of the gel membrane before it transforms into a glass microsphere as it is processed in the multiple-zone furnace.

30339 Sputter coating of microspherical substrates by levitation. Lowe, A.T.; Hosford, C.D. US Patent Application 095,681. [nd]. 26p.

Microspheres are substantially uniformly coated with metals or nonmetals by simltaneously levitating them and sputter coating them at total chamber pressures less than 1 torr. A collimated hole structure comprising a parallel array of upwardly projecting individual gas outlets is machined out to form a dimple. Glass microballoons,, which are particularly useful in laser fusion applications, can be substantially uniformly coated using the coating method and apparatus.

30340 Cryogenic target formation using cold gas jets. Hendricks, C.D. (to Dept. of Energy). US Patent 4,190,016. 26 Feb 1980. Filed date 13 Mar 1979. 8p.

PAT-APPL-20,121.

A method and apparatus using cold gas jets for producing a substantially uniform layer of cryogenic materials on the inner surface of hollow spherical members having one or more layers, such as inertially imploded targets, are described. By vaporizing and quickly refreezing cryogenic materials contained within a hollow spherical member, a uniform layer of the materials is formed on an inner surface of the spherical member. Basically the method involves directing cold gas jets onto a spherical member having one or more layers or shells and containing the cryogenic material, such as a deuterium-tritium (DT) mixture, to freeze the contained material, momentarily heating the spherical member so as to vaporize the contained material, and quickly refreezing the thus vaporized material forming a uniform layer of cryogenic material on an inner surface of the spherical member.

REPROCESSING

REFER ALSO TO CITATION(S) 30131, 30133, 30353

30341 (ORNL/TM—6377/V2, pp 109-126) **Fusion energy.** Jul 1980.

In Advanced technology section semiannual progress report, October 1, 1977-March 31, 1978. Volume 2. Engineering Science Programs.

Studies of cryosorption pumping of hydrogen with molecular sieves at temperatures between 16 and 35 K indicate that type Na-Y sieve gives significantly higher average pumping speeds than the more conventional type 5Å sieve. Apparently, pump speeds are affected by diffusion rates into the crystallite particles, and the larger pore openings in the Na-Y sieve permit higher diffusion rates. Measurements of the rate of tritium sorption from liquid lithium by yttrium coupons gave encouragingly high values despite the stagnant lithium in the contact device.

30342 (ORNL/TM—6647/V2, pp 43-95) **Hydrogen isotope technology.** Jul 1980.

In Advanced technology section semiannual progress report, April 1, 1978-September 30, 1978. Volume 2. Engineering Science Programs.

Hydrogen pumping speeds on panels of molecular sieve types 5A and Na-Y were compared for a variety of sieve (and chevron) temperatures between 10 and 30 K. Although pumping speeds declined with time, probably because of the slow diffusion of hydrogen from the surface of the sieve crystals into the internal regions, the different sieve materials and operating conditions could be compared using time-averaged pump speeds. The (average) pumping speeds declined with increasing temperature. Under some conditions, the Na-Y sieve performed much better than the 5A sieve. Studies of the effect of small concentrations (~ 4%) of hydrogen on helium pumping indicate that compound cryopumps in fusion reactors will not have to provide complete screening of hydrogen from helium panels. The concentrations of hydrogen did not lower effective helium pumping speeds or shorten the helium operating period between instabilities. Studies of tritium recovery from blankets of liquid lithium focused on design and construction of a flowing-lithium test system and on ultimate removal of tritium from yttrium sorbents. At 505°C, tritium release from yttrium behaves as a diffusion-controlled process, but the release rates are very low. Apparently, higher temperatures will be required for effective sorbent regeneration. An innovative technique for separating hydrogen isotopes by using bipolar electrolysis with permeable electrodes was analyzed to determine its potential usefulness in multistage separation.

BY-PRODUCTS

REFER ALSO TO CITATION(S) 30349, 30351, 31376

30343 (ANL/FPP/TM—131) **Fusion energy for alternate applications: development of a high temperature blanket for synthetic fuel production.** (Argonne National Lab., IL (USA)). Sep 1979. Contract W-31-109-ENG-38. 161p. NTIS, PC A08/MF A01.

Separate abstracts were prepared for the two included sections. (MOW)

30344 (ANL/FPP/TM—131, pp 83-163) **Fusion energy for alternate applications: considerations important to the selection of a synthetic fuel process.** Bowman, R.; Jody, B.; Blurton, K.F. (Inst. of Gas Tech., Chicago, IL). Sep 1979.

In Fusion energy for alternate applications: development of a high temperature blanket for synthetic fuel production.

This work was carried out in conjunction with Argonne National Laboratory, which was evaluating a high-temperature falling-bed blanket to produce thermal energy in excess of 1000°C. Therefore, the objective of this program was to determine the efficiency of a high-temperature water electrolysis system as a function of the major operating parameters and of the parameters affecting the blanket design. Based on a parametric analysis, a baseline system was formulated. The major parameters of this system were a 1200°C electrolyzer input temperature to conform to the temperature of the falling-bed blanket, a Rankine cycle with a single regenerative heating loop and turbine inlet temperature of 1200°C, a turbine efficiency of 85%, an electrolysis cell polarization of 0.2V, 80% conversion of the water in the electrolyzer, separation of H_2 from H_2O by water condensation, and parasitic losses of 5% of the electrolyzer input electrical energy. With this system, the hydrogen production efficiency was 51%. Detailed economic analysis is now required to optimize system configuration.

30345 (BNL—28007) **HYFIRE: fusion-high temperature electrolysis system.** Fillo, J.A.; Powell, J.R.; Steinberg, M.; Benenati, R.; Dang, V.D.; Horn, F.; Isaacs, H.; Lazareth, O.; Makowitz, H.; Usher, J. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract AC02-76CH00016. 5p. (CONF-800806—30). NTIS, PC A02/MF A01.

From 15. intersociety energy conversion engineering conference; Seattle, WA, USA (18 Aug 1980).

The Brookhaven National Laboratory (BNL) is carrying out a comprehensive conceptual design study called HYFIRE of a commercial fusion Tokamak reactor, high-temperature electrolysis system. The study is placing particular emphasis on the adaptability of the STARFIRE power reactor to a synfuel application. The HYFIRE blanket must perform three functions: (a) provide high-temperature (~ 1400°C) process steam at moderate pressures (in the range of 10 to 30 atm) to the high-temperature electrolysis (HTE) units; (b) provide high-temperature (~ 700 to 800°C) heat to a thermal power cycle for generation of electricity to the HTE units; and (c) breed enough tritium to sustain the D-T fuel cycle. In addition to thermal energy for the decomposition of steam into its constitutents, H_2 and O_2, electrical input is required. Power cycle efficiencies of ~ 40% require He cooling for steam superheat. Fourteen hundred degree steam coupled with 40% power cycle efficiency results in a process efficiency (conversion of fusion energy to hydrogen chemical energy) of 50%.

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

PHYSICAL ISOTOPE SEPARATION

30346 (MLM—2701) **FORTRAN program for calculating liquid-phase and gas-phase thermal diffusion column coefficients.** Rutherford, W.M. (Mound Facility, Miamisburg, OH (USA)). 9 Jul 1980. Contract AC04-76DP00053. 48p. NTIS, PC A03/MF A01.

A computer program (COLCO) was developed for calculating thermal diffusion column coefficients from theory. The program, which is written in FORTRAN IV, can be used for both liquid-phase and gas-phase thermal diffusion columns. Column coefficients for the gas phase can be based on gas properties calculated from kinetic theory using tables of omega integrals or on tables of compiled physical properties as functions of temperature. Column coefficients for the liquid phase can be based on compiled physical

property tables. Program listings, test data, sample output, and users manual are supplied for appendices.

RADIATION SOURCES

REFER ALSO TO CITATION(S) 31032, 31056, 31057

ISOTOPIC POWER SUPPLIES

30347 (MLM—2719) **Thermodynamic study of the MWG system/components and measurement of the oxygen partial pressure in the heat source capsule.** David, D.J. (Mound Facility, Miamisburg, OH (USA)). 23 Jun 1980. Contract AC04-76DP00053. 23p. NTIS, PC A02/MF A01.

A thermodynamic study of the Milliwatt Generator heat source capsule was performed to determine the effects of the oxide fuel on container materials at elevated temperatures in order to evaluate the factors affecting embrittlement of T-111 alloy. The study indicates that relatively slow oxidation of the T-111 of the capsule occurs during pretreatment. Yttrium added to the $^{238}PuO_2$ fuel charge is functioning in its designed role as an oxygen getter and is stabilizing at an O/Pu ratio of 1.75. The free energy of formation of hafnium oxide has been measured and found to be -70632 cal/mole; this suggests that the ability of hafnium to strongly function as an oxygen getter may be largely determined by the kinetics, and the free energy may play a lesser role.

HYDROGEN

PRODUCTION

ELECTROLYSIS

REFER ALSO TO CITATION(S) 30343, 30344, 30345, 30353

30348 **Mechanism of the catalytic hydrogen production by gold sols. H/D isotope effect studies.** Kopple, K. (Illinois Inst. of Technology, Chicago); Meyerstein, D.; Meisel, D. *J. Phys. Chem.;* **84**: No. 8, 870-875(17 Apr 1980).

The H/D isotope effect on the catalytic production of hydrogen from water using either Cr^{2+} or $(CH_3)_2COH$ radicals as reductants was studied. The catalysts used were gold sols stabilized by either citrate or poly(vinyl sulfate). Similar isotope effects (in the range of 5-6.7) were measured for the various reductants and stabilizers. Comparison of this isotope effect to the one measured for the production of hydrogen on gold cathodes leads to the conclusion that similar mechanisms operated in all three systems. It was also observed that hydrogen abstraction from the relatively stable supports, when adsorbed on the colloid, occurs. This leads to the conclusion that hydrogen atoms adsorbed on the particles can either proceed to produced hydrogen molecules by the catalytic reaction or react via other competing pathways.

30349 **High-temperature electrolysis.** Powell, J.R. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.;* **33**: 212-214(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

THERMOCHEMICAL PROCESSES

REFER ALSO TO CITATION(S) 30981

30350 (BHO-TR—80-1) **Chemical/hydrogen energy systems program. Annual report.** Miller, D.S. (Department of Energy, Upton, NY (USA). Brookhaven Area Office). 1 Jun 1980. 64p. NTIS, PC A04/MF A01.

The currently funded tasks administered by the Brookhaven Area Office are: hydrogen production; materials; and program support. Highlights in the hydrogen production area are: General Atomic constructed and operated a closed loop cycle demonstrator in early CY 79. This system was operated on total recycle for a time equivalent to five turnovers of the original iodine inventory. General Atomic has incorporated into their process design a number of changes which has led to an improved theoretical efficiency of 47%. Westinghouse Electric Corporation constructed and operated a laboratory model which successfully demonstrated closed cycle operation of their proposed hybrid cycle. Westinghouse published an interim report of their electrolyzer development work entitled, Investigations on Electrode Kinetics and Electrocatalysts for Sulfur Dioxide Depolarized Electrolyzers. Los Alamos Scientific Laboratory has built a laboratory scale rotary kiln and has begun studying solids decomposition at temperatures in the range of 1000-1100K. In the materials area highlights are: Lawrence Livermore has identified $CrSi_2$ coated Incaloy 800 as a very promising candidate for use in constructing the high temperature sulfuric acid vaporizer required by both General Atomic and Westinghouse. Sandia was able to demonstrate that gaseous hydrogen can be transported through the natural gas pipeline network if reasonable precautions regarding pressure are observed. IGT demonstrated that, except for meters and certain lubricants, existing distribution equipment could be used for hydrogen service for a short (to be determined) period of time. Much more testing is required to evaluate performance for long-term use.

30351 **Hydrogen production by thermochemical cycles using a fusion energy source.** Booth, L.A. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* **33**: 211-212(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

COAL GASIFICATION

30352 (FE—2855-T1) **Catalytic conversion of coal energy to hydrogen.** (TRW Defense and Space Systems Group, Redondo Beach, CA (USA). Chemistry and Chemical Engineering Lab.). Mar 1980. Contract ET-78-C-01-2855. 84p. NTIS, PC A05/MF A01.

An experimental and conceptual engineering analysis study has been performed to assess the potential of generating hydrogen by means of alkali catalyzed coal char-steam reactions. The experimental studies consisted of a fundamental catalyst research effort and a more process oriented investigation of catalyst performance. The fundamental studies were aimed at determining the nature of catalyst-fuel communication during gasification, the processes involved in catalyst deactivation, and the chemical mechanism of catalysis. The kinetics of fixed-bed conversion reactions were measured and the effects of several reaction parameters on the kinetics evaluated. On the basis of these measurements and the results of supporting studies, a major new step was taken in describing alkali catalyst behavior in catalytic char gasification. In the second part of the experimental studies, the performance of alkali catalysts in fluidized char gasification reactions was investigated. Information gained from these studies was used to develop and support a conceptual catalytic process design. In the engineering analysis studies, a conceptual design for a catalytic hydrogen process was developed and its economics analyzed and compared with other conversion processes. The hydrogen process design developed and assessed was for a catalytic version of the CO_2-Acceptor process. Results obtained from the experimental and engineering analyses indicated, at the laboratory-scale and conceptual process engineering level of investigation, catalytic hydrogen production is feasible and may offer significant technical and economic advantages over other hydrogen generation and coal conversion processes. Further catalyst research and process development work appear warranted.

STEAM-IRON PROCESS

REFER ALSO TO CITATION(S) 30109

STORAGE

CHEMISORPTION

30353 (Juel—1640) **Hydrogen in metals: significant properties and examples for their application.** Wenzl, H. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Festkoerperforschung). Jan 1980. 90p. (In German). NTIS (US Sales Only), PC A05/MF A01.

The structure, thermodynamics, and kinetics of some important alloys of hydrogen in metals are discussed in view of their use as construction materials in the hydrogen technology. Most important are the binary systems Li/H_2, Li/T_2, Mg/H_2, and the quasibinary system $FeTi/H_2$. Examples are given for the following applications: hydrogen production from water by electrolysis, purification and storage of hydrogen as chemical and nuclear fuel, heat storage, thermochemical energy conversion.

30354 **More reduced Nb_3I_8 cluster. Synthesis and structure of $CsNb_6I_{11}$ and its hydride $CsNb_6I_{11}H$.** Imoto, H.; Corbett, J.D. (Ames Lab., IA). Contract W-7405-ENG-82. *Inorg. Chem.;* **19**: No. 5, 1241-1245(May 1980).

The title compound is formed by direct reaction of Nb_3I_8 or Nb_6I_{11} with Nb and CsI in a sealed Nb tube at 910°C. The structure and composition were established by X-ray crystallography: space group $P6_322$, Z = 2, a = 11.007 (2) Å, c = 11.894 (2) Å, R = 0.047, and R/sub w/ = 0.060 for 777 independent reflections after correction for absorption and secondary extinction. The structure of $Cs^+[(Nb_6I/sup\ i/_4)I/sup\ a//sub\ 6/2/]^-$ consists of distorted metal

octahedra face-capped by I/sup i/ to give Nb_6I_8 clusters (D/sub 3d/ symmetry) which are interconnected to other octahedra in a hexagonal close-packed arrangement through bridging I/sup a/. The Nb-Nb distances range from 2.771 (2) to 2.940 (2) A, the average of 2.825 A being 0.025 (4) A less than that in the known and closely related Nb_6I_{11}(Nb_6I_8I/sub 6/2/). The observed distortion of the octahedra in both phases can be understood in terms of packing and strain at the bridging iodine atoms. The title phase is converted to the isostructural $CsNb_6I_{11}H$ by H_2 at 400°C, whereas Mo_6CL_{12}, $Na_4M_6Cl_{18}$ (M = Nb, Ta), and Ta_6Cl_{15} do not react with hydrogen at 300 to 400 °C. Hydrogen absorption by halides of transition groups 5 and 6 and zirconium appears to require an oxidation state below 2.0. The upper limits of composition (oxidation state) found for group 3 to 6 halohydrides correspond closely to the upper limits found with the binary hydrides of the same metals.

TRANSPORT

REFER ALSO TO CITATION(S) 30350

30355 (ORO—5598-T1) **Assessment of hydrogen compressor technology for energy storage and transmission systems.** Phadke, L.G.; Veziroglu, T.N.; Foster, R.W.; Escher, W.J.D. (Miami Univ., Coral Gables, FL (USA). Clean Energy Research Inst.; Escher Technology Associates, St. Johns, MI (USA)). Jan 1979. Contract EC-77-S-05-5598. 192p. NTIS, PC A09/MF A01.

An initial assessment of hydrogen compressor technology for prospective energy systems applications is documented. Hydrogen, and hydrogen/natural gas blends, are generally related to the existing state-of-the-art in natural gas compressors. Visits to natural gas transmission and storage facilities are reported on from the compressor-applications standpoint. Present applications of hydrogen compressors, as reported by both manufacturers and users are summarized. Theoretical fluid-dynamic and thermodynamic analysis of these fuel gases in compressors is provided. The implications of materials problems considered relevant to compressors are briefly discussed. Some general observations and recommendations from the assessment are presented.

30356 (UCRL-Trans—11599) **Cryopumping of hydrogen and helium.** Boissin, J.C.; Thibault, J.J.; Richardt, A. Translated from *Vide, Suppl.;* No. 157, 103-110(1972). 15p. NTIS, PC A02/MF A01.

Adsorption on an argon cryodeposit enables the application of liquid-helium cryopumps to be extended to the pumping of helium and hydrogen. The magnitudes of the pumped flows (10^{-2} t.l/s), pumped quantities (50 t.l of He, 400 t.l of H_2) and measured pumping speeds (several thousand l/s) show that, in most applications, 4.2 K cryopumps require no additional pumping facility for hydrogen and helium.

INDUSTRIAL AND COMMERCIAL USE

REFER ALSO TO CITATION(S) 30353

PROPERTIES

REFER ALSO TO CITATION(S) 31022

OTHER SYNTHETIC AND NATURAL FUELS

REFER ALSO TO CITATION(S) 31167

PROPERTIES

REFER ALSO TO CITATION(S) 31018, 31021, 31022

PREPARATION

CHEMICAL SYNTHESIS

30357 **Selectivity in the oxidative dehydrogenation of butene on zinc-iron oxide catalysts.** Kung, H.H.; Kundalkar, B.; Kung, M.C.; Cheng, W.H. (Northwestern Univ., Evanston, IL). *J. Phys. Chem.;* **84**: No. 4, 382-388(21 Feb 1980).

The oxidative dehydrogenation of butene to butadiene was studied on a zinc ferrite catalysts. Room temperature adsorption of butene on the catalyst followed by thermal desorption resulted in the production of butene isomers, butadiene, and carbon dioxide. Evidence was presented which suggests that the selective oxidation and the combustion sites are independent, and this made possible the estimation of the densities of these two oxidation sites from the amounts of oxidation products formed. Information on the reactivities of the sities was provided by temperature programmed desorption profiles of butene. Comparison of these results with those on iron oxide suggests that zinc ferrite is a more selective oxidation catalyst because it has a higher density of selective oxidation sites and a lower density of combustion sites, and because its combustion sites are less active than those on iron oxide.

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 30405, 30406, 30411, 30412, 30413, 30414, 30415

PROPERTIES

REFER ALSO TO CITATION(S) 30842, 31022

PREPARATION

CHEMICAL SYNTHESIS

30358 (ORNL—5564) **Production of methanol and methanol-related fuels from coal.** Salmon, R.; Edwards, M.S.; Wham, R.M. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 102p. NTIS, PC A06/MF A01.

This report presents a review of available information on processes for the production of methanol and methanol-related fuels from natural gas and coal. Existing commercial technology for the production of methanol from synthesis gas by the high-, low-, and intermediate-pressure processes is described. The technological and economic factors involved in the optimization of a methanol production plant are discussed. Production of synthesis gas and methanol from coal is reviewed, both from the standpoint of existing technology using Lurgi gasifiers and proposed processes using other gasifiers. An overview of the technology and economics of the Mobil MTG process for converting methanol to gasoline is presented. A search was made for obsolete or discarded processes that might be useful for the production of low-purity methanol for fuels purposes. It was concluded that none of these older processes offers any advantage over current commercial technology for fuel-grade methanol production.

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 30402, 30404, 30406, 30407, 30408, 30409, 30842

30359 (ORNL/MIT—310) **Vapor-liquid equilibrium model for a partially miscible multicomponent system: isopropanol-acetone-ethanol-n-butanol-water.** Chronis, J.H.; Amrhein, M. (Oak Ridge National Lab., TN (USA)). Jul 1980. Contract W-7405-ENG-26. 29p. NTIS, PC A03/MF A01.

Normal butanol, a potential diesel fuel additive, can be produced by the fermentation of paper pulp waste streams by Clostridia with isopropanol, acetone, and ethanol produced as byproducts. To design a distillation process for the recovery of n-butanol from fermentation broth, the vapor-liquid equilibria for the multicomponent system isopropanol-acetone-ethanol-n-butanol-water were modeled using Wilson equations to predict liquid activity coefficients. An extra parameter was added to the Wilson correlation to allow for the partial miscibility between butanol and water. The accuracy of the model was tested by comparing the predicted vapor composition with experimentally obtained values in the immiscible region. Even with the extra parameter, the model did not predict a miscibility gap between n-butanol and water, and the vapor-liquid equilibria were predicted with an accuracy of +- 0.15 mol fraction.

PREPARATION

REFER ALSO TO CITATION(S) 30523, 31005

SOLID WASTE FUELS

30360 (BM-RI—8426) **Development of analytical reference materials for refuse-derived fuels.** Law, S.L.; Haynes, B.W.; Campbell, W.J. (Department of the Interior, Washington, DC (USA)). 1980. 14p. US Dept. of the Interior, Bureau of Mines, Pittsburgh, PA.

Municipal solid waste (MSW), presently a major disposal problem, represents a significant source of metals and glass together with a combustible fraction that could be used to supplement coal

and oil and in generating heat and electricity. This combustible fraction represents 70 wt % MSW; therefore, effective utility of this fraction is an essential part of the Bureau of Mines program to conserve and increase the Nation's mineral and fuel supply through recycling of urban waste. Because of the increasing national interest in this important fuel supplement, the US Department of the Interior, Bureau of Mines prepared a refuse-derived fuel material as a proposed reference material for use by other laboratories to evaluate their analytical procedures. This reference material was prepared by combining MSW light combustibles from Tampa, FL, Montgomery County, MD, and Tulsa, OK, then shredding, milling, and blending the composite material. Homogeneity of the refuse-derived fuel reference material (RDFRM) appears to be acceptable based on analytical values for replicate analyses. Concentration data for major, minor, and trace elements together with proximate analyses are provided in this report. Aliquots of the RDFRM are available to interested laboratories upon request.

GASEOUS WASTE FUELS

30361 (NYSERDA—80-1) **Evaluation of Fresh Kills landfill gas for industrial applications.** (Institute of Gas Technology, Chicago, IL (USA); Brooklyn Union Gas Co., NY (USA)). Mar 1980. 178p. New York State Energy Research and Development Authority, Albany.

The project objective was to investigate the acceptability of landfill gas as a replacement for natural gas and imported oil fuels in industrial applications. Specific objectives included comparing and quantifying the differences between natural gas and the medium Btu landfill gas, investigating corrosion characteristics of the gas before and after combustion, quantifying the emissions resulting from combustion, and demonstrating reliable supply of landfill gas throughout the field test program. Laboratory tests evaluated the combustion characteristics of the synthesized landfill gas and determined that it was a valuable fuel resource. Based on these successful tests, a 500 h field test program was designed and performed using an industrial burner-furnace system at the Fresh Kills landfill gas recovery test site in Staten Island, New York. The landfill gas supply, combustion, and corrosion characteristics exhibited during the 500 h field test program are described.

HYDRO ENERGY

ECONOMICS AND MANAGEMENT

REFER ALSO TO CITATION(S) 30431

ENVIRONMENTAL ASPECTS

30362 (ORNL/TM—7228) **Analysis of environmental issues related to small-scale hydroelectric development. I. Dredging.** Loar, J.M.; Dye, L.L.; Turner, R.R.; Hildebrand, S.G. (Oak Ridge National Lab., TN (USA)). Jul 1980. Contract W-7405-ENG-26. 148p. NTIS, PC A07/MF A01.

The small hydroelectric potential (≦ 15-MW capacity) at existing dams in the US has been estimated to be approximately 5000 MW. Development of this resource by retrofitting these dams for hydroelectric generation may require dredging in order to (1) reclaim reservoir storage capacity lost as a result of sediment accumulation; (2) clear intake structures; and/or (3) construct/repair powerhouses, tailraces, and headraces. Dredging and disposal of dredged material at small-scale hydro sites may result in several potential environmental impacts, and their magnitude will depend upon many site-specific factors. The physical and chemical effects of dredging and disposal, their causes, and the biological effects engendered by these physical and chemical changes are discussed. Factors that could affect the severity (magnitude) of these effects (impacts) are emphasized, with the intent of providing guidance to developers of potential sites. A discussion of environmental contraints and mitigation, as well as guidelines for the early evaluation of the environmental feasibility of dredging, are included. A general introduction is provided on dredging equipment and disposal practices, with emphasis on those practices that would be applicable to small reservoirs. Regulations applicable to dredged material disposal and wetlands protection are discussed, and a preliminary analysis of the economic costs associated with dredging and disposal is presented.

SOLAR ENERGY

30363 (OTA-E—120) **Conservation and solar energy programs of the Department of Energy: a critique.** (Office of Technology Assessment (U.S. Congress), Washington, DC). 1980. 88p. GPO.

This study evaluates the progress and direction of a number of conservation and solar energy programs in order (1) to provide an overview of the balance and long-range contribution of these efforts, and (2) to discover if the programs are coherently linked to goals set by Congress and the administration. The basis of the work was generated by two advisory panels, whose members identified and discussed critical issues. The study is quite critical of C and SE, especially its objectives and the lack of clear direction from DOE management. Some the issues identified suggest how Congress and the Secretary of Energy can set the stage for C and SE to become more effective. It is pointed out where programs themselves are functioning inefficiently, and what might be done to improve them. A series of issues related to specific programs are identified for: wind, photovoltaics, solar thermal, ocean systems, biomass, transportation conservation, solar active and passive, and buildings and community systems.

30364 (SERI/SP—513-436) **Solar Energy Research Institute 1979 annual report.** (Solar Energy Research Inst., Golden, CO (USA)). 1979. Contract AC02-77CH00178. 19p. NTIS, PC A02/MF A01.

A general description of the SERI organization, facilities, programs, and progress in 1979 is presented. (WHK)

30365 (SERI/SP—644-690) **Directory of Solar Energy Research Activities in the United States: First Edition, May 1980.** (Solar Energy Research Inst., Golden, CO (USA)). May 1980. Contract AC02-77CH00178. 243p. NTIS, PC A11/MF A01.

Information covering 1220, FY 1978 and FY 1979 solar energy research projects is included. In addition to the title and text of project summaries, the directory contains the following indexes: subject index, investigator index, performing organization index, and supporting organization index. This information was registered with the Smithsonian Science Information Exchange by Federal, State, and other supporting organizations. The project summaries are categorized in the following areas: biomass, ocean energy, wind energy,photovoltaics, photochemical energy conversion, photobiological energy conversion, solar heating and cooling, solar process heat, solar collectors and concentrators, solar thermal electric generation, and other solar energy conversion. (WHK)

30366 (SERI/TR—751-472) **Solar information user priority study.** Belew, W.W.; Wood, B.L. (Solar Energy Research Inst., Golden, CO (USA)). May 1980. Contract EG-77-C-01-4042. 74p. NTIS, PC A04/MF A01.

This report identifies for each solar technology those members or potential members of the solar community who, either currently or in the future, will require solar information. In addition, it rates each user's relative need for information within the next three years. This information will be used as input for subsequent studies that will identify specific user needs information. These studies, in turn, will be the basis for information product and data base development for the Solar Energy Information Data Bank (SEIDB). In addition, they will be input for the Technical Information Dissemination (TID) Program.

RESOURCES AND AVAILABILITY

30367 (DOE/NASA/TM—78286) **ASHMET: a computer code for estimating insolation incident on tilted surfaces.** Elkin, R.F.; Toelle, R.G. (National Aeronautics and Space Administration, Huntsville, AL (USA). George C. Marshall Space Flight Center). May 1980. Contract AI01-76CS31037. 44p. NTIS, PC A03/MF A01.

A computer code, ASHMET, has been developed by MSFC to estimate the amount of solar insolation incident on the surfaces of solar collectors. Both tracking and fixed-position collectors have been included. Climatological data for 248 US locations are built into the code. This report describes the methodology of the code, and its input and output. The basic methodology used by ASHMET is the ASHRAE clear-day insolation relationships modified by a clearness index derived from SOLMET-measured solar radiation data to a horizontal surface.

30368 (NCEI—0016) **Availability of solar energy in North Carolina.** Robinson, P.J.; Easterling, W.E. (North Carolina Univ., Chapel Hill (USA). Dept. of Geology). Mar 1980. 96p. NTIS.

Radiation and meteorological records from the SOLMET data file were used to define a solar radiation climatology for North Carolina applicable to solar system design. Monthly, seasonal, and annual averages of daily total radiation on a horizontal surface and daily average ambient temperature were obtained from the long-

term records at the 6 SOLMET stations in the state. Annual average daily radiation totals are near 15 MJ/m², and monthly averages range from 7.5 MJ/m² in December to 22 MJ/m² in June. These values are lower than those previously reported by 5 to 15%, and decrease predicted yield from a typical space and water heating system by approximately 15%. Spatial radiation variations across the state are small, but coastal regions receive the maximum radiation throughout the year, while receipt in the mountains is almost equally high in winter. The minimum values occur in the Raleigh area in all seasons. The ambient temperature distribution is the most significant climatic factor influencing spatial variations in system performance, the warmer coastal areas being most favorable for solar energy generation. The relationship between daily temperatures and radiation receipt suggests that system yields are likely to be slightly below those predicted using standard methods. The nature of the temporal radiation variability indicates that these lower yields can be offset economically by oversizing collectors by about 10%. The temporal variability further indicates that storage for more than one days winter heating is uneconomic. Yield predictions depend on the relationship between radiation on a horizontal surface and radiation actually incident on a tilted collector. This relationship is uncertain, but results for Cape Hatteras indicate that actual yields are likely to be lower than those predicted by standard techniques.

30369 Northeast Utilities Environmental Data Acquisition Network solar data summaries, 1974-1979. Data from solar collecting stations in Connecticut and Western Massachusetts. Firestone, J.K.; Goodrich, R. Hartford, CT; Northeast Utilities (1980). 70p. (NP—24467).

The Northeast Utilities Environmental Data Acquisition Network was established in 1973 for the purpose of collecting meteorological, air quality, and water quality data. This information is used extensively in the research activities of Northeast Utilities Service Company. The four stations collecting total solar radiation data are scattered throughout Connecticut and Western Massachusetts, in a variety of topographical and geographical settings. Three are in Connecticut - at Waterford (the Millstone nuclear power complex), Milford (atop the roof at the Devon power station), and near Middletown (the proposed Maromas station site). The Millstone and Maromas locations are equipped with 500 foot instrument towers. The fourth station also has a 500 foot tower, and is located in Montague, Massachusetts. Data tabulated include number of hours above given total insolation level, average dry bulb temperature, average wind speed, average daily temperature, average daylight temperature, average night temperature, monthly heating degree days, monthly cooling degree days, number of heating days, number of cooling days, and average total insolation per day. Data are presented for 1974 through 1979. Instrumentation is described. (WHK)

ECONOMICS

REFER ALSO TO CITATION(S) 30432, 30502

ENVIRONMENTAL, LEGAL, AND INSTITUTIONAL ASPECTS

REFER ALSO TO CITATION(S) 30781, 30782, 31121

30370 (DOE/CS/30118—T2) **Minutes: ANSI Steering Committee on Solar Energy Standards Development.** (American National Standards Inst., New York). 29 Apr 1980. Contract AC01-79CS30118. 57p. NTIS, PC A04/MF A01.

Minutes of the April 29, 1980, meeting of the American National Standards Institute steering committee on solar energy standards development are given. Attachments include correspondence from individuals and organizations which primarily describe the Solar Public Interest Coordination Committee (SPICC) and its recent activities. Also a report on the meeting of the ANSI subcommittee on international activity is attached. (WHK)

30371 (DOE/TIC—11154) **Solar energy employment and requirements, 1978-1985: Summary and highlights.** Levy,G.W.; Field, J. (Battelle Columbus Labs., OH (USA)). Apr 1980. Contract AC01-77IR06037. 210p. NTIS, PC A10/MF A01.

This study describes the characteristics of establishments engaged in solar energy work and the number and occupational distribution of persons working in solar energy activities in 1978. The study also projects future solar manpower requirements through 1983. The scope of the study included all types of solar energy technologies and applications (space heating and cooling, water heating, industrial process heat, thermal power, ocean thermal conversion, photovoltaic conversion, wind conversion and biomass conversion), and all phases of work (research and development, manufacturing, marketing and distribution, and installation and maintenance). The data for the study were collected by a mail survey of employers engaged in solar energy activities. Questionnaires were sent to over 2800 establishments. Over 50% of those contacted responded. Detailed information was provided by 563 employers engaged in solar energy work. These employers reported the type of organization, industrial classification of their establishment, principal solar products and services, types of solar energy technologies involved, total employment and solar employment, occupations of those working in solar, number of additional solar jobs anticipated, new solar job specialities, sources of solar funding, and anticipated future commercial solar sales. Detailed results are presented and discussed. (WHK)

SOLAR ENERGY CONVERSION

PHOTOVOLTAIC CONVERSION

30372 (DOE/ET/23002—T9) **Polyacetylene, (CH)/sub x/, as an emerging material for solar cell applications. Final technical report, March 19, 1979-March 18, 1980.** Heeger, A.J.; MacDiarmid, A.G. (Pennsylvania Univ., Philadelphia (USA)). 1980. Contract AC04-79ET23002. 16p. NTIS, PC A02/MF A01.

Despite great theoretical and technological interest in polyacetylene, (CH)/sub x/, the basic features of its band structure have not been unambiguously resolved. Since photoconductivity and optical absorption data have frequently been used to infer information on the band structure of semiconductors, such measurements were carried out on (CH)/sub x/. The main results of an extensive study of the photoconductivity ($\Delta\sigma$/sub ph/) and absorption coefficient (α) in (CH)/sub x/ are presented. The absence of photoconductivity in cis-(CH)/sub x/, despite the similarity in optical properties indicates that $\Delta\sigma$/sub ph/ in trans-(CH)/sub x/ is induced by isomerization. It is found that isomerization generates states deep inside the gap that act as safe traps for minority carriers and thereby enhance the photoconductivity. Compensation of trans-(CH)/sub x/ with ammonia appears to decrease the number of safe traps, whereas acceptor doping increases their number. Thus, chemical doping can be used to control the photoconductive response. The energy of safe traps inside the gap is independent of the process used to generate them; indicative of an intrinsic localized defect level in trans-(CH)/sub x/. A coherent picture based on the soliton model can explain these results, including the safe trapping.

30373 (DOE/ET/23047—4) **Thin film polycrystalline silicon solar cells. Final report, January 1-December 31, 1979.** Ghosh, A.K.; Feng, T.; Maruska, H.P. (Exxon Research and Engineering Co., Linden, NJ (USA). Advanced Energy Systems Labs.). 1979. Contract AC03-79ET23047. 108p. NTIS, PC A06/MF A01.

A theory of the electrical and photovoltaic properties of polycrystalline silicon is presented. In this theory it is shown that grain boundary states play a dominant role in determining these properties of silicon. Since the grain boundary area is proportional to the grain size, these properties are related to the grain sizes. The recombination loss at grain boundaries is the predominant loss mechanism in polycrystalline solar cells. For small grain sizes, the grain boundary recombination centers affect the minority carrier lifetime more than the dopant even at large concentrations. One could fabricate 10% efficiency polycrystalline solar cells with 20 μm thick material if the grain sizes were greater than 500 μm .The results show that tremendous improvements in device performance can be achieved either by increasing the grain size or passivating the grain boundary states to reduce the number of recombination centers. The details of the fabrication procedures for making SnO_2/n-Si, ITO/n-Si, MIS and diffused p/n junction solar cells are presented. The effects of grain boundaries on the generation of photocurrent were studied in the Scanning Electron Microscope using the EBIC technique. In addition to using the intensity modulated mode, a y-modulation technique, which gave more details, was used in the EBIC studies. By studying the Hall mobility of polysilicon in the dark and under illumination, we have developed a phenomenological theory which is capable of explaining the observed resistivity and mobility results. A comparison of the spectral response curves of SnO_2/n-Si heterojunction ad diffused p/n junction cells indicates a lower diffusion length in the diffused cells.

30374 (DOE/ET/23103—16) **Theory of thin-film photovoltaics. Eight month summary report.** Boeer, K.W. (Delaware Univ., Newark (USA). Coll. of Engineering). 1979. Contract AC01-79ET23103. 131p. NTIS, PC A07/MF A01.

The program called for further development of the physics theory of thin-film photovoltaics with the goal to identify important experimental parameters and their optimum range, to prepare means to measure, monitor and adjust such parameters in order to provide guidance for obtaining solar cells with improved cost-efficiency. Specifically, it was proposed to improve the present diode plus current generator model and reduce the improved model to a workable bench-type model. Following the proposed program it was

first attempted to obtain a better understanding of non-ideal characteristics. As a result of this work, we are now able to classify such characteristics in nonexponentia! and exponential characteristics, caused mainly by a difference in junction (interface) recombination with s/sub j/ $\sim >$ 10^6 cm/s and s/sub j/ $\sim <$ 10^6 cm/s for the two groups respectively. From the first group, one can easily extract junction material parameters such as the trap level distribution near the Fermi level, maximum fields and the widths of the junction. From the second group, such determination is no longer possible; however, a wide range of exponential A-factors, even in excess of 2, can be explained with changing interface recombination, caused by transition saturation. The obtained results can be expressed in a simple algebraic form and this provides a very encouraging basis for developing a bench-type model. Experiment and theory are in good agreement.

30375 (DOE/ET/23106—2) **Photovoltaic mechanisms in polycrystalline thin film silicon solar cells. Technical progress report No. 2, 1 November 1979-31 January 1980.** Temofonte, T.A.; Szedon, J.R.; Fonash, S.J.; Ashok, S.; Lester, P.A. (Westinghouse Research and Development Center, Pittsburgh, PA (USA); Pennsylvania State Univ., University Park (USA)). 1980. Contract AC01-79ET23106. 53p. NTIS, PC A04/MF A01.

A consistent effect has been observed with MIS cells on p-base material for which surface etching has been done using 25:10:3 and 1:5:5 compositions of the HNO_3:HAc:HF etchant. The former composition produces smooth mid-grain silicon surfaces with some preferential attack at grain boundaries, while the latter yields an overall surface texturing whose morphological detail is grain dependent. Electrically, cells on surfaces etched with the 25:10:3 composition present more tightly distributed behavior in terms of logarithm of I/sub photo/ vs V/sub oc/ characteristics. This suggests that dependence of total diode opposing current on cell voltage and hence the reverse diode saturation currents are less variable for the polishing etch. There has been poor correlation between electrical behavior of the small diagnostic cells used and the density of grain boundaries deduced from preferential etch effects or grain surface morphology. As reported previously for Czochralski-grown polycrystalline material, there is considerable variation in the electrical activity of grain boundaries revealed by chemical means. Furthermore, with the Wacker SILSO material, the magnitude of maximum photocurrent loss at electrically active grain boundaries is only about 12% compared with values of 30 to 40% for Czochralski material. Also careful analysis of V/sub oc/ suppression in Wacker polycrystalline silicon etched to a final thickness of 50 μm gives a conservatively estimated value for the effective minority carrier diffusion length of 110 μm. Characterization efforts have involved comparisons of MS and MIS barrier cells on polycrystalline and single crystal material. No etchant-related effects have been noted, but the polycrystalline material produces cells whose dark current behavior appears to be controlled by multi-step tunneling as regards its temperature and voltage dependence.

30376 (DOE/ET/23110—T1) **Investigation of efficiency loss mechanisms in CdS/Cu_2S and related thin-film solar cells. Final report, 23 May 1979-22 May 1980.** Serway, R.A.; Annamalai, N.K. (Clarkson Coll. of Tech., Potsdam, NY (USA); Solar Energy Research Inst., Golden, CO (USA)). 30 Jun 1980. Contract AC01-79ET23110. 187p. NTIS, PC A09/MF A01.

After completing the fabrication facilities, the CdS/Cu/sub X/S solar cells were produced by sequential evaporation. The cells thus fabricated have a maximum J/sub sc/ of 11 mA/cm^2 and V/sub oc/ of 0.51 V. The maximum values did not occur simultaneously. The series resistance of the cells were high and hence the efficiency of the cells were low. Few cells had efficiencies in the range of 1.8 to 1.89%. The fabrication of Cu/sub x/S layer are yet to be optimized to improve the output of the cells. The heat treatment studies were conducted on films and cells. The photoconductive decay, Hall effect measurement, Auger analysis, resistivity measurement as a function of temperature were made on our fabricated films and cells and the results are presented. An automated system to measure the capacitance was designed and constructed. The capacitance of IEC CdS/Cu/sub x/S solar cells was measured as a function of temperature, frequency and voltage. The dark capacitance can be modeled according to the work of Hall and Singh while the photocapacitance obeys the model of Schibli and Milnes. Anomalies in the normal C-V curve were seen for the first time and are attributed to deep trapping states int he CdS i-layer. The Hall effect and resistivity measurements on IEC cells are used to characterize the growth of the surface oxide layer on the Cu/sub x/S films. The I-V measurements on the cells as a function of heat treatment and time corroborates the above results. Ion Scattering Spectroscopy was used to study the surface composition of cells.

30377 (DOE/JPL/954355—79/3) **Large area silicon sheet by EFG. Annual progress report, October 1, 1978-September 30, 1979.** (Mobil Tyco Solar Energy Corp., Waltham, MA (USA)). 14 Mar 1980. Contract NAS-7-100-954355. 76p. NTIS, PC A05/MF A01.

The progress which has been made in 1978/1979 to evolve systems designs for growth stations which produce multiple silicon ribbons by the EFG process is reported. This progress culminated in the demonstration of five ribbon multiple growth in May 1979 and in recent advances toward improved electronic quality of ribbons grown from these machines. These advances were made in large measure by studies in which the composition of the gas environment around the meniscus area was varied. By introducing gases such as CO_2, CO, and CH_4 into this region, reproducible increases in diffusion length and cell performance have been realized, with the best large area (5 cm x 10 cm) cells exceeding 11% (AM1) efficiency.

30378 (DOE/JPL/954654—80/11) **Silicon web process development. Annual report.** Duncan, C.S.; Seidensticker, R.G.; McHugh, J.P.; Hill, F.E.; Skutch, M.E.; Driggers, J.M.; Hopkins, R.H. (Westinghouse Research and Development Center, Pittsburgh, PA (USA)). 30 Jun 1980. Contract NAS-7-100-954654. 184p. NTIS, PC A09/MF A01.

During this reporting period significant milestones have been met. A new barrier crucible design which consistently maintains melt stability over long periods of time has been successfully tested and used in long growth runs. The pellet feeder for melt replenishment was operated continuously for growth runs of up to 17 hours (a one day growth cycle). The liquid level sensor comprising a laser/sensor system was operated, performed well, and meets the requirements for maintaining liquid level height during growth and melt replenishment. An automated feedback loop connecting the feed mechanism and the liquid level sensing system was designed and constructed and, during the preparation of this report, operated successfully for 3 1/2 hours demonstrating the feasibility of semi-automated dendritic web growth. The web throughput task has resulted in a demonstration of wider good quality web as well as a demonstration of higher throughput rates. The accomplishments during the report period are described in detail. The economic analysis of the dendritic web process was updated. The sensitivity of the cost of sheet to variations in capital equipment cost and recycling dendrites was calculated; and it was shown that these factors have relatively little impact on sheet cost. An important finding was that dendrites from web which had gone all the way through the solar cell fabrication process, when melted and grown into web, produce crystals which show no degradation in cell efficiency. Material quality remains high and cells made from web grown at the start, during, and the end of a run from a replenished melt show comparable efficiencies.

30379 (DOE/JPL/954882—80/21) **Process development for automated solar cell and module production. Task 4: automated array assembly.** Hagerty, J.J. (MB Associates, San Ramon, CA (USA)). 30 Jun 1980. Contract NAS-7-100-954882. 187p. NTIS, PC A09/MF A01.

The scope of work under this contract involves specifying a process sequence which can be used in conjunction with automated equipment for the mass production of solar cell modules for terrestrial use. This process sequence is then critically analyzed from a technical and economic standpoint to determine the technological readiness of each process step for implementation. The process steps are ranked according to the degree of development effort required and according to their significance to the overall process. Under this contract the steps receiving analysis were: back contact metallization, automated cell array layup/interconnect, and module edge sealing. For automated layup/interconnect both hard automation and programmable automation (using an industrial robot) were studied. The programmable automation system was then selected for actual hardware development. Economic analysis using the SAMICS system has been performed during these studies to assure that development efforts have been directed towards the ultimate goal of price reduction. Details are given. (WHK)

30380 (DOE/JPL/955055—80/5) **Silicon solar cell process development, fabrication and analysis. Quarterly report for period ending December 31, 1979.** Minahan, J.A. (Spectrolab, Inc., Sylmar, CA (USA)). 1980. Contract NAS-7-100-955055. 63p. NTIS, PC A04/MF A01.

Solar cells have been fabricated from unconventional sheet silicon in Phase II of this contract. Preparations have been made for measurement of cells under AM1 conditions. This has been accomplished by utilization of existing Pyrex water filters in combination with the X-25 Spectrolab Solar Simulator. Several experimental runs have been made utilizing screen printed silver contacts. Mobil-Tyco EFG silicon, Westinghouse web silicon and Crystal Systems heat exchange method silicon have been fabricated into solar cells by the baseline process.

30381 (DOE/JPL/955640—80/2) **Development and fabrication of a solar cell junction processing system. Quarterly report No. 2, July 1980.** Siesling, R. (Jet Propulsion Lab., Pasadena, CA (USA)). Jul 1980. Contract NAS-7-100-955640. 35p. NTIS, PC A03/MF A01.

The basic objectives of the program are the following: (1) to design, develop, construct and deliver a junction processing system

which will be capable of producing solar cell junctions by means of ion implantation followed by pulsed electron beam annealing; (2) to include in the system a wafer transport mechanism capable of transferring 4-inch-diameter wafers into and out of the vacuum chamber where the ion implantation and pulsed electron beam annealing processes take place; (3) to integrate, test and demonstrate the system prior to its delivery to JPL along with detailed operating and maintenance manuals; and (4) to estimate component lifetimes and costs, as necessary for the contract, for the performance of comprehensive analyses in accordance with the Solar Array Manufacturing Industry Costing Standards (SAMICS). Under this contract the automated junction formation equipment to be developed involves a new system design incorporating a modified, government-owned, JPL-controlled ion implanter into a Spire-developed pulsed electron beam annealer and wafer transport system. When modified, the ion implanter will deliver a 16 mA beam of $^{31}P^{+}$ ions with a fluence of 2.5 x 10^{15} ions per square centimeter at an energy of 10 keV. The throughput design goal rate for the junction processor is 10^{7} four-inch-diameter wafers per year.

30382 (DOE/JPL/955696—80/1) **Laser annealing of ion implanted CZ silicon for solar cell junction formation. Quarterly report No. 1.** Katzeff, J.S. (Lockheed Missiles and Space Co., Sunnyvale, CA (USA)). Jul 1980. Contract NAS-7-100-955696. 35p. NTIS, PC A03/MF A01.

A project to evaluate the merits of large spot size pulsed laser annealing of ion implanted silicon wafers for junction formation on solar cells is described. A Q-switched Nd:Glass laser system is used operating in the 1064 (regular) and 532 (with frequency doubler) nm wavelengths. The laser output is in excess of 30 joules with a 20 to 50 ns pulse duration. Material used in this investigation is 3-inch diameter CZ silicon, P-type 0.014 inches thick, 10Ω-cm resistivity, <100> orientation. Three wafer surface conditions are being evaluated in this pulse annealing investigation: chem-polished, texture etched, and flash etched. Annealing was performed with and without beam homogenization. Both modes showed excellent lattice recovery from the implant-induced damage as analyzed using Rutherford backscattering techniques. Homogenization of the beam was performed using a fused silica rod configured with a 90° bend. The unhomogenized annealing was performed using a plano-concave lens. Fabrication of laser annealed cells using both modes is forthcoming.

30383 (HEDL-TC—1599) **Electro-thermal infrared scanning method for polycrystalline solar cells.** Green, D.R. (Hanford Engineering Development Lab., Richland, WA (USA)). Jul 1980. Contract AC14-76FF02170. 31p. NTIS, PC A03/MF A01.

Techniques for rapidly scanning solar cells to determine differences in basic parameters at different locations should provide improved understanding of fabrication variables that infuence polycrystalline cell performance. Hence, such techniques should aid development of efficient polycrystalline cells, and provide rapid feedback to correct or optimize manufacturing variables. An electro-thermal method of scanning cells, using a sensitive noncontacting infrared scanner to map temperatures produced by a current pulse, has been demonstrated. Single-crystal Al/Si as well as polycrystalline Al/Si and Cu/Cu_2O thin-film Schottky barrier cells were included in this work. Laser scans in which cell short circuit output was mapped as a function of light-spot position were performed for comparison with the electro-thermal infrared results. Some basic mechanisms involved in the electro-thermal results have been proposed. However, they are not yet completely understood. Experimental results are presented, and some of the proposed relationships between basic cell parameters and electro-thermal scan results are discussed. Although the work was conducted mainly with Schottky diodes, the electro-thermal method can also be applied to N-P and P-N photovoltaic cells.

30384 (HEDL-TC—1728) **Applications of ellipsometry to solar cell research.** Green, D.R.; Olsen, L.C. (Hanford Engineering Development Lab., Richland, WA (USA)). Jul 1980. Contract AC14-76FF02170. 15p. NTIS, PC A02/MF A01.

Ellipsometry can be utilized for both optical and structural characterization of materials. Possible applications of ellipsometry to solar cell development include determination of thickness and optical constants of: (1) thin insulator films formed on semiconductor substrates, such as used in MIS cells; (2) semiconductor films or substrates; (3) metal films; and (4) antireflection (AR) coatings. These applications are discussed; the basic equations of ellipsometry are presented; and commercial ellipsometers are described. (WHK)

30385 (K/CSD/INF—79/23) **Laser annealing of solar cell wafers.** Giles, G.E.; Kirkpatrick, J.R.; Wood, R.F. (Union Carbide Corp., Oak Ridge, TN (USA). Nuclear Div.; Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 8p. (CONF-800723—11). NTIS, PC A02/MF A01.

From 19. national heat transfer conference; Orlando, FL, USA (27 Jul 1980).

Laser annealing of ion implanted silicon offers great promise in the manufacture of low cost, high efficiency solar cells and other semiconductor devices. A high-power, short pulse laser beam is used to melt a thin surface layer which resolidifies leaving a regrown single crystal structure. The dopant atoms tend to occupy substitutional sites. The damage to the crystal produced by the dopant implantation process is removed producing a better semiconductor device than the conventional method of thermal annealing. Numerical methods for heat transfer with phase change and for dopant diffusion during melting are presented with comparison to experimental data.

30386 (PNL—3319) **Evaluation of critical materials for five advanced design photovoltaic cells with an assessment of indium and gallium.** Watts, R.L.; Gurwell, W.E.; Jamieson, W.M.; Long, L.W.; Pawlewicz, W.T.; Smith, S.A.; Teeter, R.R. (Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1980. Contract AC06-76RL01830. 335p. NTIS, PC A15/MF A01.

The objective of this study is to identify potential material supply constraints due to the large-scale deployment of five advanced photovoltaic (PV) cell designs, and to suggest strategies to reduce the impacts of these production capacity limitations and potential future material shortages. This report presents the results of the screening of the five following advanced PV cell designs: polycrystalline silicon, amorphous silicon, cadmium sulfide/copper sulfide frontwall, polycrystalline gallium arsenide MIS, and advanced concentrator-500X. Each of these five cells is screened individually assuming that they first come online in 1991, and that 25 GWe of peak capacity is online by the year 2000. A second computer screening assumes that each cell first comes online in 1991 and that each cell has 5 GWe of peak capacity by the year 2000, so that the total online cpacity for the five cells is 25 GWe. Based on a review of the preliminary basline screening results, suggestions were made for varying such parameters as the layer thickness, cell production processes, etc. The resulting PV cell characterizations were then screened again by the CMAP computer code. Earlier DOE sponsored work on the assessment of critical materials in PV cells conclusively identified indium and gallium as warranting further investigation as to their availability. Therefore, this report includes a discussion of the future availability of gallium and indium. (WHK)

30387 (SAND—79-7053) **Low cost photovoltaic concentrator array: a novel design utilizing glass-reinforced concrete.** Taylor, J.R. (Sandia National Labs., Albuquerque, NM (USA)). Jun 1980. Contract AC04-76DP00789. 272p. NTIS, PC A12/MF A01.

MBAssociates (MBA) has designed and built a prototype of a Low Cost Photovoltaic Concentrator Array. This array features the development of a two-axis tracking system which is designed to support high concentration point-focus collectors (up to 400 suns). In addition to the cost advantages of reducing the expensive cell area in a high concentration Fresnel lens collector system, this array consists primarily of spray-molded glass-reinforced concrete (GRC) as the low-cost structura material that most advantageously meets system rigidity requirements. Another innovation consists of usng a GRC spherical module support structure which floats in an aqueous lubricant and serves as a spherical bearing about which the system turns. This large spherical bearing distributes loads without the use of expensive precision parts. The only precision components are two gear-head motors used to drive the sphere in two axis of motion. A 3/8-scale model tracking system and a full-scale high concentration (100 x solar, 80 x geometric) prototype collector module were built during this program. Detailed design, performance, and cost data are presented. (WHK)

30388 (SERI/PR—0-8276-1) **Thin-film polycrystalline silicon solar cells. Technical progress quarterly report No. 1, September 25-December 24, 1979.** Faughnan, B.W.; Blanc, J.; Phillips, W.; Redfield, D. (RCA Labs., Princeton, NJ (USA)). Jan 1980. Contract EG-77-C-01-4042. 39p. NTIS, PC A03/MF A01.

The laser scanner has been improved in resolution and convenience of operation. The analysis of grain-boundary laser-photoresponse line shape at $\lambda = 1.5$ μm yields a value for the grain boundary surface recombination velocity, i.e., $s = 1.0 \times 10^{4}$ cm/s. New experiments are underway in: (1) deep-level spectroscopy, where a sample is being fabricated with a grain boundary level spectroscopy, where a sample is being fabricated with a grain boundary parallel to the surface; (2) liquid-crystal technique for measuring grain boundaries, by improving the electrical contacts to the sample; and (3) electron channeling patterns, by examining grains which have been previously laser-scanned. Hydrogenation experiments on phosphorus-diffused Wacker Silso solar cells yield negative results even when grain-boundary activity is monitored by the sensitive laser scanning method. Experiments are planned on bare silicon by a laser-scan-photoconductivity technique. Phosphorus diffusion down grain boundaries has been observed by bevel and stain experiments on a variety of diffused and implanted junctions in the temperature range of 750° to 950°C. Diffusion spike lengths vary from 1/3 to 1 1/2 times the junction depth, and between 25 to 75% of the grain boundaries show these spikes. Laser scanning experi-

ments show that grain boundaries with diffusion spikes are not electrically active. A new series of bicyrstals was begun with a <110> growth direction. So far, a crystal with a 30° misorientation has been successfully grown.

30389 (SERI/PR—0-8276-2) **Thin-film polycrystalline silicon solar cells. Technical progress quarterly report No. 2.** Faughnan, B.W.; Blanc, J.; Phillips, W.; Redfield, D. (RCA Labs., Princeton, NJ (USA)). Jun 1980. Contract AC02-77CH00178. 36p. NTIS, PC A03/MF A01.

A continuing study of the characterization of grain boundaries in polycrystalline silicon is reported. The solar cells fabricated in this quarter, which include a complete set of bicrystals and cells made on two different types of potentially low-cost substrates, are listed. Some detailed QE measurements on a Wacker Silso cell are described and the difference between bulk and average diffusion length is explained. It is shown how the average QE curve can be used to calculate the AM-1 short-circuit current with excellent accuracy. The laser scanner has been improved further and excellent scans are obtained at wavelengths of 633 nm and 1150 nm. These are discussed along with a new photoconductivity-laser-scan technique for observing grain boundaries in bare silicon, i.e., with no diffused junction. Recent developments in other grain boundary characterization techniques are described. These include the liquid-crystal technique for observing grain boundaries, the use of a bicrystal with grain boundary parallel to the sample surface for DLTS measurements, and the measurement of grain crystallographic orientation by electron-channeling patterns in a previously laser-scanned sample of Wacker Silso silicon.

30390 (SERI/PR—8104-2-T1) **Commercialization of a thick film solar cell. Quarterly technical progress report, April 1, 1980-June 30, 1980.** (Globe-Union, Inc., Milwaukee, WI (USA)). 1980. Contract AC02-77CH00178. 28p. NTIS, PC A03/MF A01.

Samples of screen printed cadmium sulfide were supplied to the Institute of Energy Conversion of the University of Delaware for the application of copper sulfide via the evaporated cuprous chloride technique. Results of this activity are not available at this time. Problems were encountered in reproducing the previously obtained low resistivity cadmium sulfide films. The probable cause of this problem is in the atmosphere control for the furnace. The furnace has been extensively modified. When completed the modifications will permit greater control over the atmosphere, flow rate, and composition. A trial solar cell was prepared. While its short circuit current and open circuit voltage are low, present procedures for applying the currous chloride appear adequate. An attempt was made to apply the cuprous sulfide layer via a screen printed, fired-on copper electrode. The resultant copper electrode lacked adhesion to the cadmium sulfide layer.

30391 (SERI/PR—8104-4-T1) **Low-cost process for P-N junction-type solar cell.** Mooney, J.B.; Lamoreaux, R.H.; Bates, C.W. Jr. (Stanford Univ., CA (USA)). Jun 1980. Contract AC02-77CH00178. 38p. NTIS, PC A03/MF A01.

$CuInSe_2$ films have been deposited by spray pyrolysis. Thermodynamic studies show that the preparation of single-phase stoichiometric films is less probable than the analogous $CuInS_2$, owing to the relative ease of dissociation of H_2Se. Examination of films by optical absorption verifies these predictions. A heterojunction of glass/SnO_2(Sb)/n-CdS/p-CdS/p-$CuInSe_2$Au configuration exhibited the photovoltaic effect with low efficiency but without the cracking that resulted with the $CuInS_2$ devices. Two sintered n-CdS/p-CdTe devices exhibited photovoltaic effect with low efficiency. The resistivity of the CdS films has been reduced to 2 OMEGA-cm.

30392 (SERI/PR—8119-1-T1) **Supported growth of polycrystalline silicon sheet on low-cost ceramic, carbon, or reusable substrate. Quarterly report No. 3, 1 April-30 June 1980.** Chapman, P.W.; Heaps, J.D.; Schuldt, S.B.; Zook, J.D. (Honeywell Corporate Material Sciences Center, Bloomington, MN (USA)). 31 Jul 1980. Contract AC02-77CH00178. 34p. NTIS, PC A03/MF A01.

The overall objective of this program is to identify and develop high-throughput, supported-growth method for producing low-cost, large-area polycrystalline silicon sheet on ceramic, carbon, or reusable substrates. The growth methods being investigated are SCIM-coating and top-coating techniques. SCIM is an acronym for Silicon Coating by Inverted Meniscus. With this technique, a low-cost ceramic substrate is silicon-coated in a continuous manner by passing the substrate over a molten-silicon meniscus which is contained in a narrow fused-silica trough. Asymmetric (fast) growth modes are also being thermally analyzed and experimentally investigated using the SCIM method to improve the coating throughput and hence the cost-effectiveness of the continuous-coating process. With the top-coating technique, molten silicon is metered onto the top carbonized surface of a moving substrate. This technique also has the potential for being a fast-thoughput method, since the thickness of the silicon coating is dictated by the quantity of molten silicon metered onto the substrate rather than the coating rate, as is the case in the SCIM technique. Progress during the past quarter is summarized.

30393 (SERI/PR—8254-1-T1) **Amorphous thin films for solar-cell applications. Quarterly report No. 1, 11 September-10 December 1979.** Carlson, D.E.; Crandall, R.S.; Dresner, J.; Goldstein, B.; Hanak, J.J.; Moore, A.R.; Pankove, J.I.; Weakliem, H.A. (RCA Labs., Princeton, NJ (USA)). Dec 1979. Contract AC02-77CH00178. 64p. NTIS, PC A04/MF A01.

Research progress on amorphous Si:H solar cells is described. Tasks include theoretical modeling, deposition and doping studies, experimental characterization of a-Si:H, formation of solar cell structures, and evaluation of solar cell parameters. A new method for determining the drift mobility of majority carriers in doped a-Si:H is discussed. Deposition and doping studies have been performed in an rf magnetron discharge system. Mass spectroscopy has been used to show that the major impurities in the SiH_4 discharge occur at m/e values of 45, 47, and 49 at concentrations 10^{-4}-10^{-5} times that of the principal ion, SiH_3^+. Boron implantation of an i-n structure produces a p-i-n cell with an enhanced V/sub oc/ but reduced J/sub sc/ as compared to cells in a nonimplanted region. Laser annealing at power densities up to 60 MW/cm² (30-ns pulse) causes partial crystallization of the a-Si:H, but there are no significant changes in the photoluminescence spectrum or the hydrogen content. the photo-Hall effect in undoped a-Si:H has been measured as a function of wave-length and temperature. The photoelectromagnetic spectrum for the short-circuit current has been used to estimate a hole diffusion length of ~0.1-0.3 μm in undoped a-Si:H. Recently p-i-n cells have been fabricated with conversion efficiencies up to ~ 4.5%. Both boron and phosphorus concentrations were found to vary inversely with rf power for doped a-Si:H films made in an rf capacitive discharge. Solar cells have also been fabricated with a-(Si,Ge):H alloys. (WHK)

30394 (SERI/PR—8254-1-T2) **Amorphous thin films for solar-cell applications. Quarterly report No. 2, 11 December 1979-10 March 1980.** Carlson, D.E.; Crandall, R.S.; Dresner, J.; Goldstein, B.; Hanak, J.J.; Moore, A.R.; Pankove, J.I.; Weakliem, H.A. (RCA Labs., Princeton, NJ (USA)). Mar 1980. Contract AC02-77CH00178. 78p. NTIS, PC A05/MF A01.

Measurements of both primary and secondary photocurrents for photon energies between 0.58 and 2.0 eV in a-Si:H solar-cell structures have been used to provide information about the density of states above the valence band as well as show that holes are mobile deep in the bandgap. The drift mobility is independent of excitation energy, indicating that the majority carriers are excited to the same states, irrespective of the excitation energy. Deposition studies in the dc proximity system have shown that the conductivity and photoconductivity of doped films (both boron- and phosphorus-doped) increase with substrate temperature. Mass spectroscopy studies have shown that the larger Si/sub x/H/sub y/$^+$ clusters are favored by operating rf discharges at low rf powers and high pressures. The Hall mobility is roughly constant below 360 K but exhibits a thermal activation energy of ~ 0.13 eV at higher temperatures. These observations rule out simple extended-state transport as the conduction mechanism. The photoelectromagnetic effect has been used to estimate the hole lifetime (~ 3.4 x 10^{-7}s) in undoped a-Si:H; the electron lifetime is ~ 1.7 x 10^{-6}s. An a-Si:H monolithic solar panel consisting of 16 cells in series has been fabricated on a 4" x 4" glass substrate (63 cm² of active area), and the panel exhibits a conversion efficiency of 3.6%. In another series of experiments, the thicknesses and doping levels of p-i-n cells made in a dc(P) discharge were optimized. The best cell made in these experiments had an efficiency of 5.3% with an area of 1.19 cm².

30395 (SERI/PR—8278-1-T1) **Vacuum deposited polycrystalline silicon films for solar cell applications. Quarterly report, September 15-December 31, 1979.** Feldman, C.; Arrington, C.H.; Blum,, N.A.; Satkiewicz, F.G. (Johns Hopkins Univ., Laurel, MD (USA). Applied Physics Lab.). Mar 1980. Contract AC02-77CH00178. 60p. NTIS, PC A04/MF A01.

Polycrystalline silicon films 14-22 μm thick and with average grain diameters of 20-40 μm were deposited by vacuum deposition onto both ceramic and sapphire substrates which were previously coated with a thin (1-2 μm) TiB_2 conducting layer. The large grains are the result of an interaction in the initial growth stages between silicon and TiB_2. SIMS studies of B/Ti/Al_2O_3, B/Al_2O_3, and Ti/Al_2O_3, interactions are reported as part of a continuing investigation of TiB_2 formation and silicon interactions on the TiB_2 surface. The increase in grain size has led to an improvement in the open-circuit voltage V/sub oc/, but not to an increase in the short-circuit current J/sub sc/. Capacitance-voltage measurements give results characteristic of an abrupt junction and a build-in voltage V/sub D/ consistent with the measured doping levels. A simple method for measuring the minority carrier diffusion length in the base region L/sub n/ is described. The measurements indicate that there is little change in L/sub n/ between large (20-40 μm) and small (~ 5 μm) grained samples.

30396 (SERI/PR—8278-1-T2) **Vacuum deposited polycrystalline silicon films for solar cell applications. Second quarterly technical progress report. January 1-March 31, 1980.** Feldman, C.; Arlington, C.H. III; Blum, N.A.; Satkiewicz, F.G. (Johns Hopkins Univ., Laurel, MD (USA). Applied Physics Lab.). May 1980. Contract AC02-77CH00178. 55p. NTIS, PC A04/MF A01.

A careful study of a specially formed thin silicon layer on TiB_2-coated sapphire reveals that the interaction layer of $TiSi_2$ is composed of larger grains. Processing steps were developed which lead closer to the goal of fabricating polycrystalline silicon photovoltaic devices completely by vacuum deposition. Both n-type and p-type silicon are now being deposited. New deposition masks were made for depositing the n-regions upon the p-layers. New electrode deposition masks were also made for a direct electroding process to replace the photolithographic process used previously. The TiB_2 bottom electrode fabrication has been achieved in a single vacuum chamber. Reaction constants and activation energy for TiB_2 layer formation were determined to be less than those reported by other authors for bulk material. Studies of crystallite growth and interfacial interactions have continued. Major sources of undesirable impurities have been identified and removed from the vacuum chambers. The changes made this quarter have not been incorporated into a completed photovoltaic device.

30397 (SERI/PR—9075-1-T1) **Materials studies related to the Cu_2S/ZnCdS heterojunction. First quarter report, March 15, 1980-June 15, 1980.** Burton, L.C. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA). Dept. of Electrical Engineering). Jul 1980. Contract AC02-77CH00178. 34p. NTIS, PC A03/MF A01.

Work over the first quarter was directed toward compositional measurements of Cu_2S/ZnCdS junctions by AAS and AES, and modelling of the junction based on these measurements. AAS and AES measurements both indicate an accumulation of Zn under the interface. AES profiles indicate Zn and Cd in the Cu_2S, although AAS indicates concentrations below 5×10^{19} cm^{-3}. A model based on lateral composition variation at the interface is presented. This model can account for some of the trends seen in Cu_2S/ZnCdS cells, especially the decrease in short circuit current at higher Zn compositions.

30398 (SERI/TR—98146-1) **Materials analysis methods for examination of solar cells. Final report.** Wilson, C.N. (ed.). (Hanford Engineering Development Lab., Richland, WA (USA)). Mar 1980. Contract EG-77-C-01-4042. 111p. NTIS, PC A06/MF A01.

Photovoltaic device performance depends on properties of thin-surface and near-surface layers of solid-state materials. Cell structures being investigated by SERI subcontractors for solar cells typically involve one or more thin-film layers of semiconducting material. The chemical and physical structure of these layered material systems affects photovoltaic cell performances. In particular, the composition, abruptness, and chemical nature of layer interfaces are important. Also of interest is the degree of crystallinity, grain size and orientation, and the physical nature of grain boundaries within the various layers. Comprehensive examination of the structure and chemistry of photovoltaic materials requires application of several analysis methods. The objectives of this report are: (1) to describe the materials analysis techniques available to SERI through the HEDL contract, and (2) to provide a user's guide to SERI and SERI contractors to guide them in the use of these materials analysis services. Some general considerations concerning materials analysis classification are discussed in this report, and the applications and capabilities of specific techniques are summarized in the tables. Eight techniques having high potential for characterization of photovoltaic materials are briefly described. These eight techniques are: AES, IMMA, Electron Microscopy, EPMA, XRF, XRD, SSMS and NAA.

30399 **Dye-sensitized solar cells.** Skotheim, T.A. (to Dept. of Energy). US Patent 4,190,950. 4 Mar 1980. Filed date 24 Mar 1978. 6p.

PAT-APPL-889,688.

A low-cost dye-sensitized Schottky barrier solar cell is described comprised of a substrate of semiconductor with an ohmic contact on one face, a sensitizing dye adsorbed onto the opposite face of the semiconductor, a transparent thin-film layer of a reducing agent over the dye, and a thin-film layer of metal over the reducing agent. The ohmic contact and metal layer constitute electrodes for connection to an external circuit and one or the other or both are made transparent to permit light to penetrate to the dye and be absorbed therein for generating electric current. The semiconductor material chosen to be the substrate is one having a wide bandgap and which therefore is transparent; the dye selected is one having a ground state within the bandgap of the semiconductor to generate carriers in the semiconductor, and a first excited state above the conduction band edge of the semiconductor to readily conduct electrons from the dye to the semiconductor; the reducing agent selected is one having a ground state above the ground state of the sensitizer to provide a plentiful source of electrons to the dye during current generation and thereby enhance the generation; and the metal for the thin-film layer of metal is selected to have a Fermi level in the vicinity of or above the ground state of the reducing agent to thereby amply supply electrons to the reducing agent.

30400 **Applications of Auger electron spectroscopy and secondary ion mass spectroscopy in solar energy research.** Kazmerski, L.L. (Solar Energy Research Inst., Golden, CO). *Trans. Am. Nucl. Soc.;* **33**: 245-246(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30401 **Characterization of ion-implanted, laser-annealed silicon for solar cell applications.** White, C.W. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **33**: 246-248(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

BIOMASS PRODUCTION AND CONVERSION

REFER ALSO TO CITATION(S) 30359, 30360, 30361, 30842, 31197

30402 (ANL/SPG—9) **Grain ethanol as a petroleum substitute: a perspective.** Alston, T.G. (Argonne National Lab., IL (USA)). Apr 1980. Contract W-31-109-ENG-38. 29p. NTIS, PC A03/MF A01.

Present tax exemptions for gasohol are more than sufficient to move ethanol into the gasoline market in a number of states. The principal near-term response to this profit opportunity, production of ethanol from feed grains, matches a limited biomass resource to an enormous market. This report estimates upper-bound prices for feed grains resulting from gasohol tax exemptions and concludes that grain price increases could be substantial. As shown else-where by Alston and Asbury, industrial uses constitute a more economical market for grain ethanol, one in which the product is now competitive with ethanol derived from petroleum and natural gas liquids. Without tax exemptions for gasohol, grain ethanol would now be displacing petroleum in the industrial market at a net economic gain, rather than in the fuel market at a net economic loss. The present analysis indicates that this industrial market for ethanol could grow significantly, principally by use of grain ethanol as an intermediate in production of chemicals now derived from petroleum and natural gas.

30403 (CONF-800482—2) **Environmental effects of harvesting forests for energy.** Van Hook, R.I.; Johnson, D.W.; West, D.C.; Mann, L.K. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 17p. NTIS, PC A02/MF A01.

From Bio-energy world congress and exposition; Atlanta, GA, USA (21 Apr 1980).

Present interest in decreasing US dependence on foreign oil by increasing the use of wood for energy may bring about a change in our forest utilization policies. In the past, forests have been removed in areas believed to be suited for agriculture, or sawtimber and pulp have been the only woody material removed in any quantity from land not generally considered tillable. The new demands on wood for energy are effecting a trend toward (1) removing all woody biomass from harvested areas, (2) increasing the frequency of harvesting second growth forests, and (3) increasing production with biomass plantations. Considering the marginal quality of much of the remaining forested land, the impacts of these modes of production could be significant. For example, it is anticipated that increased losses of nutrients and carbon will occur by direct forest removal and through erosion losses accelerated by forest clearing. There are, however, control measures that can be utilized in minimizing both direct and indirect effects of forest harvesting while maximizing woody biomass production.

30404 (CONF-800629—3) **DOE small scale fuel alcohol plant design.** LaRue, D.M.; Richardson, J.G. (Idaho National Engineering Lab., Idaho Falls (USA)). 1980. Contract AC07-76ID01570. 13p. NTIS, PC A02/MF A01.

From Symposium on commercial uses of geothermal energy; Boise, ID, USA (16 Jun 1980).

The Department of Energy, in an effort to facilitate the deployment of rural-based ethanol production capability, has undertaken this effort to develop a basic small-scale plant design capable of producing anhydrous ethanol. The design, when completed, will contain all necessary specifications and diagrams sufficient for the construction of a plant. The design concept is modular; that is, sections of the plant can stand alone or be integrated into other designs with comparable throughput rates. The plant design will be easily scaled up or down from the designed flow rate of 25 gallons of ethanol per hour. Conversion factors will be provided with the final design package to explain scale-up and scale-down procedures. The intent of this program is to provide potential small-scale producers with sound information about the size, engineering requirements, costs and level of effort in building such a system.

30405 (COO—4388-8) **Liquid fuels production from biomass. Progress report No. 8, April 1-June 30, 1979.** Sanderson, J.E.; Garcia-

Martinez, D.V.; George, G.S.; Dillon, J.J.; Molyneaux, M.S.; Barnard, G.W.; Wise, D.L. (Dynatech Corp., Cambridge, MA (USA)). 23 Jul 1979. Contract AC02-77ET20050. 118p. NTIS, PC A06/MF A01.

The current program to convert biomass into liquid hydrocarbon fuels is an extension of the previous program to ferment marine algae to acetic acid. In that study, it was found that marine algae could be converted to higher aliphatic organic acids and that these acids could be readily removed from the fermentation both by membrane or liquid-liquid extraction. It was then proposed to convert these higher organic acids to aliphatic hydrocarbons via Kolbe Electrolysis, which may be used as a diesel fuel. The accompishments in this program for the first year of work are as follows: a coenzyme M anologue, 2-bromoethanesulfonic acid has been shown to be an effective suppressor of methane in nonsterile anaerobic fermentation of cellulosic substrates; a tapered auger device has been designed and built which has been demonstrated on the bench to be effective for adding substrate and removing residue in a continuous manner from a fixed packed bed fermenter; a solvent extracter system using kerosene as the nonaqueous phase has been constructed and is currently in operation in series with the 300 liter fixed packed bed fermenter; although additional work is required to optimize the electrolysis process the electrolytic oxidation of organic acids produced in the 300 liter fixed packed bed fermenter is operating with a favorable energy balance of 6/1 based on the applied potential; the liquid-liquid extractor system is operating in line with 300 liter fixed packed bed fermentor; the other components of an integrated continuous system, the continuous feed device and the Kolbe electrolysis cell are operating satisfactorily out of line on a scale compatible with the 300 liter fixed packed bed fermentor; and an economic analysis for a 1000 ton per day plant has been performed and has been improved and updated based on additional experimental results.

30406 (DOE/CS/56051—1) **Biomass as a feedstock for highway vehicle fuels: a resource and availability survey.** (Mueller Associates, Inc., Baltimore, MD (USA)). Dec 1979. Contract EX-76-C-01-2098. 54p. NTIS, PC A04/MF A01.

The study was initiated because of the recognized need to compile a concise description of biomass as an energy base for liquid transportation fuels (namely alcohols) for highway vehicles. The aim is to provide a brief familiarization of biomass-related terminology to those with limited technical background and to present a summary assessment of the potential that biomass can provide as a resource base for liquid transportation fuels. Biomass may play a significant role in supplying liquid fuels for transportation (indeed, for other sectors, as well), however, there are fundamental limitations imposed by the size of the biomass, resource, production and distribution economics, and the difficulty of ensuring sustained availability for an extended period of time. Bioconversion is one of a number of developing energy options that individually, may make relatively small contributions but in the aggregate, are likely to be significant. Thus, research and development related to fuels from biomass and their utilization continue to be major areas of activity sponsored by the Department of Energy.

30407 (LBL—10319) **Chemical process research and development program, FY 1979.** (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Feb 1980. Contract W-7405-ENG-48. 42p. NTIS, PC A03/MF A01.

This report contains the annual progress attained within the Energy and Environment Division of Lawrence Berkeley Laboratory in 1979. Separate abstracts are prepared for individual items. (DC)

30408 (LBL—10319, pp 4.2-4.8) **Process development studies on the bioconversion of cellulose and production of alcohol.** Wilke, C.R.; Blanch, H.W.; Rosenberg, S.L.; Tangnu, S.K.; Sciamanna, A.F.; Freitas, R.P. Feb 1980.

In Chemical process research and development program, FY 1979.

Progress in the acid and enzymatic hydrolysis of bagasse and wood is reported for 1979. Studies on a new strain of fungus was begun. Cellulase and xylanase production is compared with that of T viride. Ethanol fermentation media nutrients are discussed. Ethanol production from xylanose is reported. (DC)

30409 (LBL—10319, pp 4.9-4.14) **Low-cost, low-energy flash ethanol fermentation.** Maiorella, B.; Blanch, H.W.; Wilke, C.R. Feb 1980.

In Chemical process research and development program, FY 1979.

The flash-ferm process for the fermentation of ethanol is described. The cost benefits and energy requirements are discussed. Cost for the combined flash-ferm and vacuum distillation process is given. (DC)

30410 (LBL—10319, pp 4.14-4.17) **Studies on the physiology and enzymology of lignin degradation.** Rosenberg, S.L.; Wilke, C.R. Feb 1980.

In Chemical process research and development program, FY 1979.

Studies of biological lignin degradation were undertaken in order to see if this process could be incorporated in our current scheme for the bioconversion of lignocellulosic materials to ethyl alcohol. The presence of lignin in natural cellulosic materials protects some of the cellulose and other carbohydrates from enzymatic attack. Removal of the lignin increases the amount of carbohydrate subject to enzymatic saccharification and, thus, the amount of ethanol obtainable. The goal of this research was the demonstration of a cell-free lignin-degrading enzyme system.

30411 (LBL—10319, pp 4.19-4.20) **Pretreatment of biomass prior to liquefaction.** Schaleger, L.; Yaghoubzadeh, N.; Ergun, S. Feb 1980.

In Chemical process research and development program, FY 1979.

A series of bench-scale experiments on the hydrolysis of green wood chips were conducted and a set of conditions which resulted in the production of a slurry having superior rheological properties was established. After appropriate procedural and equipment modifications were made, these results were duplicated on a 200-gal scale by Rust Engineering Corp., operators of the DOE-Albany facility. A subsequent liquefaction run at Albany succeeded in producing 6 bbls of purely wood-derived oil from prehydrolyzed wood slurry. Thus the chemical feasibility of the LBL approach was demonstrated. In this report the studies on pretreatment which culminated in the successful production of oil at Albany are detailed.

30412 (LBL—10319, pp 4.21-4.23) **Catalytic liquefaction of biomass.** Seth, M.; Djafar, R.; Yu, G.; Ergun, S.; Vermeulen, T. Feb 1980.

In Chemical process research and development program, FY 1979.

Work on this project began in November 1978. We reviewed the literature on the hydrogenation and hydrogenolysis of wood, cellulose, lignin, and sugars. Based on this review, 20 potential catalysts were screened. Both the review and the results of the screening experiments have been reported. These experiments led to the identification of ferric chloride as an effective reagent for wood liquefaction. The objectives of this project are: to undertake bench-scale studies leading to improvements in the present liquefaction process; to formulate and conduct exploratory research for the identification and development of new, integrated processes for biomass liquefaction; to investigate the characteristics and stability of biomass liquids; and to explore and develop options for the upgrading and utilization of liquids from biomass. The selection and development of integrated process concepts generally proceeds in three phases. The first phase involves exploratory catalyst screening. Several potential catalysts are screened at standard conditions based on the chemical approach being pursued. The effect of process variables is then investigated for the most promising catalytic systems. Finally, changes that could result in improved process economics or process operation are tested and evaluated. Two related aspects of the project are concerned with the analysis and characterization of products and with product upgrading and utilization.

30413 (LBL—10319, pp 4.24-4.26) **Monitoring the biomass liquefaction process development unit at Albany, Oregon.** Ergun, S.; Figueroa, C.; Karatas, C. Feb 1980.

In Chemical process research and development program, FY 1979.

LBL monitored the Albany operations through an independent analysis of the raw data obtained, and plant modifications proposed and planned. Analysis of production difficulties, coupled with in-house research, led LBL researchers to seek alternative processes. A literature survey by LBL revealed that catalysts other than sodium carbonate had been utilized by researchers in converting wood and wood components (especially lignin and cellulose) into oil and chemicals (phenols, high boiling alcohols, etc.). Promising catalysts were evaluated. Researchers conducted a comprehensive test run that established conclusions about the existing process chemistry. In April, 1979, after consultation with Rust Engineering Company (the plant operators), LBL issued an operating directive to test the chemical and technical feasibility of a modified process that appeared promising on the basis of results obtained at LBL. This test run was conducted during the first week of May, 1979, and for the first time an oil derived from wood was obtained in large quantities. Noting that the number of tests that can be conducted at Albany are limited and would be insufficient for a systematic investigation of the influences of the various process variables to arrive at optimum conditions, LBL proposed the construction of a continuous process evaluation unit that would simulate the Albany Facility and incorporate a tubular reactor that is lacking at Albany. During FY 79, LBL designed, fabricated and procured the necessary equipment for the continuous unit. The construction of this unit will be completed in December 1979. It is anticipated that the unit will be operational during February, 1980. The expected oil production rate is between 2.5 to 5 gallons per day if operated on a 24 hour basis.

30414 (LBL—10319, pp 4.26-4.27) **LBL continuous biomass liquefaction process engineering unit (PEU).** Ergun, S.; Figueroa, C.; Karatas, C.; Wrathall, J. Feb 1980.

In Chemical process research and development program, FY 1979.

The intent of the PEU was to provide engineering support to the Albany, Oregon PDU. However, it later became clear that basic engineering design data for slurry pumping and the reactor would be the final product. Undertaking this task meant long-term planning as high-pressure equipment generally has long delivery times. By January 1979, a detailed schematic for the PEU was finalized. Major or minor equipment investigations, specifications, and procurement commenced and proceeded into late 1979. Completion of major piping, electrical, and instrumentation is expected by December 1979. Preliminary shakedown testing will continue for three months, after which a preliminary liquefaction run is expected by March 1980. During the months of October and November, 1979, extensive testing of the PEU slurry pumping capabilities took place and is the subject of an unpublished report. Findings from this study indicate that hydrolyzed biomass slurries of 20% can be easily pumped without any difficulties. The key to this capability apparently lies with the slurry ability to uptake gas (approximately 10% by volume).

30415 (LBL—11019) **Catalytic biomass liquefaction. Quarterly report, January-March 1980.** Ergun, S.; Djafar, R.; Figueroa, C.; Karatas, C.; Schaleger, L.; Seth, M.; Wrathall, J.; Yaghoubzadeh, N.; Yu, G. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1980. Contract W-7405-ENG-48. 12p. NTIS, PC A02/MF A01.

Progress during the quarter in the chemical characterization of the products of wood liquefaction is reported. The liquefaction of hydrolyzed slurries in a tubular reactor bomb system is described. The solvolytic depolymerization of wood is compared to the hydrolysis process. Results of a few illustrative runs are pesented. The characterization and flow properties of concentrated slurries are discussed. Progress on the construction of biomass continuous liquefaction unit is described.

PHOTOCHEMICAL AND THERMOCHEMICAL CONVERSION

REFER ALSO TO CITATION(S) 31002

30416 (BNL—28028) **Primary change separation and a biomimetic model of photosynthetic oxygen evolution.** Davis, M.S.; Forman, A.; Fujita, I.; Netzel, T.L.; Fajer, J. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract AC02-76CH00016. 3p. (CONF-800827—2). NTIS, PC A02/MF A01.

From 3. international conference on photochemical conversion and storage of solar energy; Golden, CO, USA (3 Aug 1980).

The transformation of light into the chemical energy that drives the fixation of CO_2 and the evolution of O_2 in green plant photosynthesis is mediated by two photosystems (PS I and PS II). The initial photoreactions in both photosystems consist of the absorption of light by chlorophyll a (Chl a) and the subsequent formation of chlorophyll π-cation radicals by photoejection of electrons to nearby acceptors. The identity and chemical nature of the primary donor and acceptor of PS II are considered. These species are of prime concern to biomimetic solar energy conversion because the primary photosynthetic reaction produces a strong oxidant capable of driving O_2 evolution, and because the electronic configurations of the donor and acceptor must influence the efficient forward electron transfer from the donor while inhibiting efficient wasteful back reactions of the photoproduced cation and anion radicals.

PHOTOVOLTAIC POWER PLANTS

REFER ALSO TO CITATION(S) 30502, 31121

30417 (COO—4094-83) **Materials, Processes and Testing Laboratory. Technical progress report: July, August, September, October 1979.** Forman, S.E.; Themelis, M.P. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 15 Mar 1980. Contract AC02-76ET20279. 56p. NTIS, PC A04/MF A01.

The US Department of Energy has set a 20-year lifetime goal for terrestrial photovoltaic modules. In its capacity as a Photovoltaic Field Test and Application Center, Massachusetts Institute of Technology Lincoln Laboratory has established various experimental test sites, ranging in size from 0.1 to 25 kW of peak power, throughout the United States. These sites contain modules from several manufacturers and serve as test beds for photovoltaic system components. This report, the sixth in a series of similar reports, summarizes the activities of the Materials, Processes and Testing Laboratory of the Solar Photovoltaic Field Tests and Applications Project during the four-month period, 1 July 1979 through 31 October 1979. During this period, field inspections of test sites at Bryan, Ohio, and Mead, Nebraska, were conducted and are reviewed. An inordinate module failure rate at the University of Texas at Arlington is reviewed and analyzed. Failures and degradation of Mead, Nebraska, modules are analyzed, and the development of testing equipment for PV systems is discussed.

30418 (DOE/CS/05313—1) **Commercial Application of a Photovoltaic Concentrator system. Phase I. Final report, 1 June 1978-28 February 1979.** Anderson, D.J.; Anderson, E.R.; Bardwell, K.M. (BDM Corp., Albuquerque, NM (USA)). Apr 1980. Contract ET-78-C-04-5313. 384p. NTIS, PC A17/MF A01.

This report documents the design and analysis of the BDM CAPVC (Commercial Application of a Photovoltaic Concentrator) system. The preliminary design, prototype test and evaluation, system analysis, and final design of a large-scale concentrating photovoltaic system are described. The application is on an attractive new office building which represents a large potential market. The photovoltaic concentrating array is a roof-mounted, single-axis linear parabolic trough, using single crystalline silicon photovoltaic cells. A total of 6720 square feet of aperture is focussed on 13,944 PV cells. The photovoltaic system operates in parallel with the local utility in an augmentary loadsharing operating mode. The array is actively cooled and the thermal energy utilized for building heat during winter months. (WHK)

30419 (DOE/CS/34218—T1) **SPS energy conversion and power management workshop. Final report.** (Alabama Univ., Huntsville (USA). Kenneth E. Johnson Environmental and Energy Center). Jun 1980. Contract AS01-78CS34218. 98p. NTIS, PC A05/MF A01.

In 1977 a four year study, the concept Development and Evaluation Program, was initiated by the US Department of Energy and the National Aeronautics and Space Administration. As part of this program, a series of peer reviews were carried out within the technical community to allow available information on SPS to be sifted, examined and, if need be, challenged. The SPS Energy Conversion and Power Management Workshop, held in Huntsville, Alabama, February 5 to 7, 1980, was one of these reviews. The results of studies in this particular field were presented to an audience of carefully selected scientists and engineers. This first report summarizes the results of that peer review. It is not intended to be an exhaustive treatment of the subject. Rather, it is designed to look at the SPS energy conversion and power management options in breadth, not depth, to try to foresee any troublesome and/or potentially unresolvable problems and to identify the most promising areas for future research and development. Topics include photovoltaic conversion, solar thermal conversion, and electric power distribution processing and power management. (WHK)

30420 (DOE/ET/20279—98) **100-kWp photovoltaic power system at Natural Bridges National Monument.** Solman, F.J.; Helfrich, J.H.; Lyon, E.F.; Benoit, A.E. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 1980. Contract AC02-76ET20279. 4p. (CONF-800806—26). NTIS, PC A02/MF A01.

From 15. intersociety energy conversion engineering conference; Seattle, WA, USA (18 Aug 1980).

The Natural Bridges National Monument in southeastern Utah is the location of the world's largest solar photovoltaic power system. This system, which operates in a stand-alone mode without utility backup, supplies from 300 to 400 kWh/day of 60-Hz AC electrical energy to the diversified loads in the monument headquarters area. A diesel-powered generator serves as backup for the system. The solutions to a number of problems encountered in the design, fabrication, testing and early operation of the system are discussed.

30421 (DOE/ET/23060—1) **Photovoltaic Power System for the Santa Clara Community Recreation Center. Final report, 30 September 1978-31 March 1979.** McCargo, M.; Cunnington, G.R.; Lott, D.R.; Leacock, S.R.; Thimgan, D.C.; Davis, N. (Lockheed Palo Alto Research Labs., CA (USA)). Apr 1980. Contract AC04-78ET23060. 192p. NTIS, PC A09/MF A01.

This final report documents the work performed in Phase I of the conceptual design of a 30-kW Photovoltaic Power System (PPS) for the City of Santa Clara Community Recreation Center (CRC). Detailed system analysis and optimization studies were carried out to develop system performance criteria as a function of insolation characteristic and energy cost (dollars/kWh). A single free-standing structure housing the array and all electrical equipment was chosen as the optimum system design. A lightweight steel space frame concept was adapted using a 125 x 125 ft Unistrut structure supported on four 10 x 10 ft reinforced concrete columns. The directly south-facing photovoltaic subarrays, 4 x 4 ft, are mounted atop the spaceframe in rows 5 ft apart inclined at 26 degrees to the horizontal. The system optimization analysis included module electrical parameters; subarray panel size, spacing and electrical interconnector patterns; shadowing effects; array orientation; and clear-day and average-day insolation conditions. Potential benefits derived from tracking and the use of plane reflectors were also examined. Compo-

nent specifications were defined for the photovoltaic array modules, power conditioning system and utility interface components. Qualification and performance testing of the candidate photovoltaic modules (OCLI and ARCO) was performed by the Jet Propulsion Laboratory, and the results were used as input data to the system analysis program. As a result of the optimized system design and analysis, a fabrication, installation, and operations plan was detailed for the Phase II and Phase III efforts. Included in the plan was a detailed consideration of the nontechnical issues associated with the implementation of the conceptual PPS.

30422 (DOE/ET/23061—1) **25 kW solar photovoltaic flat panel power supply for an electrodialysis water desalination unit in New Mexico. Final report, 1 October 1978-31 May 1979.** Wood, J.R.; Crutcher, J.L. (Mobil Tyco Solar Energy Corp., Waltham, MA (USA)). Jun 1980. Contract AC04-78ET23061. 100p. NTIS, PC A05/MF A01.

The stand-alone system designed by Mobil Tyco Solar Energy Corporation consists of a 25 kW flat panel array employing silicon ribbon solar cells, used in conjunction with a lead-acid battery bank to provide the complete power requirements of an electrodialysis water desalination unit. The Mobil Tyco system design is intended to be prototypical of part of the drinking water supply for a remote village. The specific task which this system will perform during Phase III is to aid in the restoration of an aquifer following a uranium leaching operation by the Energy Minerals Division of Mobil Oil Corporation at a site which is approximately four miles from the township of Crownpoint in northwestern New Mexico. System design is described, and a detailed description of a mathematical model and computerized simulation of the system is included. (WHK)

30423 (DOE/ET/23064—1) **194 kilowatt solar photovoltaic flat panel power system for the combined Beverly High School/C.H. Patten Vocational High School, Beverly, Massachusetts. Final technical report, October 1, 1978-March 31, 1979.** Addiss, R.R. Jr.; Lawson, P.A. (Solar Power Corp., Woburn, MA (USA)). Jun 1980. Contract AC04-78ET23064. 202p. NTIS, PC A10/MF A01.

The 194 kW system consists of the photovoltaic array, the inverter/control subsystem, the building and utility interface, and the monitoring subsystem. The photovoltaic array consists of 56 separate subarrays of 112 photovoltaic modules each, deployed in rows on the southerly facing slope north of the school building. The wiring scheme permits individual modules to be disconnected without a radical change in subarray output current. Power is transmitted at 4160 V from the inverters and a step-up transformer to the main 4160 V utility feed line in the school. Separate metering measures power bought and sold. At the optimum tilt angle of 40°, the array provides 232 MWh of ac energy annually, or 17% of the school load. It provides a good match to the summer daily load profile, resulting primarily from the central air-conditioning. Some power is sold to the utility throughout the year, mainly on weekends. The immediate impact is an $8000 saving in the annual utility bill. Levelized busbar energy costs are reduced from $2/kWh to $1/kWh when site-specific parameters are used in the analysis instead of the JPL-specified nominal values. A fault detection and isolation scheme which can find a single module failure is incorporated into the monitoring subsystem.

30424 (DOE/JPL/955149—1(App.)) **Residential photovoltaic module and array requirement study. Low-Cost Solar Array Project engineering area. Final report appendices.** (Burt, Hill, Kosar, Rittlemann, and Associates, Butler, PA (USA)). Jun 1979. Contract NAS-7-100-955149. 569p. NTIS, PC A24/MF A01.

This volume contains the appendices to a study to identify design requirements for photovoltaic modules and arrays used in residential applications. Appendices include: (1) codes, standards, and manuals of accepted practice-definition and importance; (2) regional code variations-impact; (3) model and city codes-review; (4) National Electric Code (NEC)-review; (5) types of standards-definition and importance; (6) federal standards-review; (7) standards review method; (8) manuals of accepted practice; (9) codes and referenced standards-summary; (10) public safety testing laboratories; (11) insurance review; (12) studies approach; (13) mounting configurations; (14) module/panel size and shape cost analysis; (15) grounding, wiring, terminal and voltage studies; (16) array installation cost summary; (17) photovoltaic shingle/module comparison; (18) retrofit application; (19) residential photovoltaic module performance criteria; (20) critique of JPL's solar cell module design and test specifications for residential applications; and (21) CSI format specification. (WHK)

30425 (SERI/TR—80959-1) **Standards for photovoltaic energy conversion systems. Final report.** Schafft, H.A. (National Bureau of Standards, Washington, DC (USA)). Apr 1980. Contract EG-77-C-01-4042. 19p. NTIS, PC A02/MF A01.

This report provides the results of a search for existing domestic standards and related documents for possible application in the development of a standards base for photovoltaic energy conversion systems. The search resulted in locating about 150 test methods, recommended practices, standards, solar-thermal performance criteria, and other standards-related documents. They are listed by topic areas in the appendix. The listing was prepared to assist those involved in developing performance criteria for photovoltaic systems and in identifying methods to test system performance against these criteria. It is clear from the results of the search that few standards are directly applicable to terrestrial solar photovoltaic systems and that much standards development is required to support the commercialization of such systems.

SOLAR THERMAL POWER PLANTS

REFER ALSO TO CITATION(S) 30419, 30463, 30532, 30537, 30539, 30543, 30727, 31121

30426 **Solar heat pipe feedback turbogenerator.** Decker, B.J. US Patent 4,122,356. 24 Oct 1978. Filed date 13 Jul 1976. 12p.

The conversion of radiant heat to electricity by a heat pipe-turbogenerator combination is described. The heat pipe-tubogenerator assembly is suitably externally insulated, as by a vacuum shield, to prevent heat losses and heat is recovered from the condenser portion of the heat pipe and returned to the evaporator portions. An application of the generic invention is discussed which it is employed on wall or roof portions of a building and serves as at least a partial supporting structure for these. In another application the solar heat pipe feedback turbogenerator may be incorporated in or used with reflective means, such as reflective sheet material of large area positioned to direct solar radiation onto the evaporator section of the heat pipe. The reflective means may be changed in position to follow the sun to produce maximum power during operation.

30427 (DOE/CS/21036—01) **Solar thermal power systems. Summary report.** (Aerospace Corp., El Segundo, CA (USA)). Jun 1980. Contract AI01-79ET21036. 153p. NTIS, PC A08/MF A01.

The work accomplished by the Aerospace Corporation from April 1973 through November 1979 in the mission analysis of solar thermal power systems is summarized. Sponsorship of this effort was initiated by the National Science Foundation, continued by the Energy Research and Development Administration, and most recently directed by the United States Department of Energy, Division of Solar Thermal Systems. Major findings and conclusions are sumarized for large power systems, small power systems, solar total energy systems, and solar irrigation systems, as well as special studies in the areas of energy storage, industrial process heat, and solar fuels and chemicals. The various data bases and computer programs utilized in these studies are described, and tables are provided listing financial and solar cost assumptions for each study. An extensive bibliography is included to facilitate review of specific study results and methodology.

30428 (PNL—4000(Vol.2)) **Assessment of solar options for small power systems applications. Volume II. Identification and characterization of concepts for analysis.** Laity, W.W.; Aase, D.T.; Apley, W.J.; Bird, S.P.; Drost, M.K.; Williams, T.A. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jun 1980. Contract AC06-76RL01830. 300p. NTIS, PC A13/MF A01.

The primary purpose of this study is to provide DOE with an independent, objective assessment of the principal solar thermal conversion concepts that have the potential for achieving commercial success as small electric power sytems in the 1- to 10-MWe range. Seven generic types of collectors, together with associated subsystems for electric power generation, were considered in this study. The collectors can be classified into three categories: (1) two-axis tracking (with compound curvature reflecting surfaces); (2) one-axis tracking (with single-curvature reflecting surfaces); and (3) nontracking (with low-concentration reflecting surfaces). These collectors can be combined with energy transport, energy storage, and power conversion subsystems in a wide variety of ways to formulate conceptual systems for electric power generation. In this study, attention was restricted to configurations that are potentially suitable for development as small power systems (1 to 10 MWe) in the long term (1990 to 2000), with initial commercialization by the mid-1980s. Cogeneration and total energy systems were beyond the scope of this study. All seven types of collectors were analyzed in conceptual system configurations with Rankine-cycle engines. Because they can operate at particularly high concentration ratios, two of the collectors (the Point Focus Central Receiver and the Point Focus Distributed Receiver) were also analyzed with Brayton-cycle engines. In addition, the latter of the two was analyzed with Stirling-cycle engines. With these engine options, 10 conceptual systems were formulated for analysis. Results are presented in detail. (WHK)

30429 (SAND—80-0865(Rev.)) **Line-focus solar thermal energy technology development. FY 79 annual report for Department 4720.** Bergeron, K.D.; Champion, R.L.; Hunke, R.W. (eds.). (Sandia Na-

tional Labs., Albuquerque, NM (USA)). Apr 1980. Contract AC04-76DP00789. 144p. NTIS, PC A07/MF A01.

The primary role of the Solar Energy Projects Department II (4720) is the development, evaluation, and testing of line-focus solar thermal technology. This report of FY 79 progress and accomplishments is divided into two parts: (1) Component and Subsystem Development including the design and analysis of collector modules, their components, and associated materials and processes, and (2) Systems and Applications Development, involving larger configurations of solar thermal line-focus systems. The emphasis is on parabolic troughs, but significant efforts on hemispherical bowls, compound parabolic collectors, and dishes for the Solar Total Energy Project are also described.

30430 (SAND—80-8505) **Department of Energy large solar central power systems semiannual review.** (Sandia Labs., Albuquerque, NM (USA)). Jun 1980. Contract AC04-76DP00789. 350p. NTIS, PC A15/MF A01.

Separate abstracts were prepared for the 37 papers presented. (WHK)

30431 (SAND—80-8505, pp 61-71) **Solar/hydro integration study.** Hightower, S.J. (Water and Power Resources Service, Denver, CO). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

The Water and Power Resources Service (Service), with joint funding from the Department of Energy (DOE) has completed an appraisal-level study to determine the technical and economic feasibility of integrating solar powerplants with the federal hydroelectric power system in the southwestern United States. The 12-month study began in February 1979 and was completed in January 1980. The concept of solar/hydro integration utilizes the hydro facility as an energy storage system for the solar plant. Technical feasibility of the concept was determined by evaluating the effects of integration on the hydrologic and power operations of the existing hydro system. Economic feasibility was determined by comparing the costs of the integrated system with that of the most likely alternative source of power generation. Additional objectives of the study were to recommend the best site for installation of the initial solar plant and to recommend an implementation plan for a feasibility design study. Results are reported. (WHK)

30432 (SAND—80-8505, pp 75-83) **Economic assessment of advanced solar-thermal power systems.** Day, J.T. (Westinghouse Electric Corp., East Pittsburgh, PA). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

The Advanced Systems Technology Division of Westinghouse Electric Corporation is engaged in a study to perform an economic evaluation of several advanced solar-thermal concepts in the role of central station electric generating plants. The objective of the study is to estimate the value of several advanced solar-thermal concepts through detailed modelling of their operation on utility systems. Parametric analysis is being performed on major plant parameters such as collector area, storage capacity, penetration and location. Also, sensitivity to economic assumptions is being investigated. Progress is reported. (WHK)

CENTRAL RECEIVER

REFER ALSO TO CITATION(S) 30460, 30461, 30462, 30464, 30465, 30466

30433 (SAN—1108-76-8(Vol.7)) **Central receiver solar thermal power system, Phase 1: CDRL Item 2, pilot plant preliminary design report. Volume VII. Pilot plant cost and commercial plant cost and performance.** Hallet, R.W. Jr.; Gervais, R.L. (McDonnell Douglas Astronautics Co., Huntington Beach, CA (USA)). May 1980. Contract EY-76-C-03-1108. 306p. (MDC-G—6776(Vol.7)). NTIS, PC A14/MF A01.

Detailed cost and performance data for the proposed tower focus pilot plant and commercial plant are given. The baseline central receiver concept defined by the MDAC team consists of the following features: (A) an external receiver mounted on a tower, and located in a 360° array of sun-tracking heliostats which comprise the collector subsystem. (B) feedwater from the electrical power generation subsystem is pumped through a riser to the receiver, where the feedwater is converted to superheated steam in a single pass through the tubes of the receiver panels. (C) The steam from the receiver is routed through a downcomer to the ground and introduced to a turbine directly for expansion and generation of electricity, and/or to a thermal storage subsystem, where the steam is condensed in charging heat exchangers to heat a dual-medium oil and rock thermal storage unit (TSU). (D) Extended operation after daylight hours is facilitated by discharging the TSU to generate steam for feeding the admission port of the turbine. (E) Overall control of the system is provided by a master control unit, which handles the interactions between subsystems that take place during startup, shutdown, and transitions between operating modes. (WHK)

30434 (SAN—1110-8(Vol.7)) **Central receiver solar thermal power system, Phase 1. Pilot plant cost and commercial plant cost and performance preliminary design report.** (Martin Marietta Corp., Denver, CO (USA)). 1977. Contract EY-76-C-03-1110. 148p. (MCR—77-156(Vol.7)). NTIS, PC A07/MF A01.

Detailed cost and performance data for the 10 MWe Pilot Plant and the 150 MWe Commercial Plant are given. The Commercial Plant consists of 15 integrated collector - receiver modules. Each module contains 1325 heliostats and an internally mounted steam-generating receiver on a steel tower with an aperture height of 90 M. The Pilot Plant consists of one full-scale collector - receiver module. The two-stage sensible heat storage system utilizes a heat transfer salt medium and a hydrocarbon oil storage medium. The electric power generation system uses a conventional steam turbine-generator. The Pilot Plant is one module of the Commercial Plant, providing for one-to-one scaling in the most critical areas. (WHK)

30435 (SAN—1483-1/4) **Conceptual design of Advanced Central Receiver Power Systems sodium-cooled receiver concept: development plan and pilot plant description. Final report.** (Rockwell International Corp., Canoga Park, CA (USA)). Mar 1979. Contract EG-77-C-03-1483. 147p. (ESG—79-2(Vol.3)). NTIS, PC A07/MF A01.

This volume encompasses Task 6 of the Phase I effort on the Advanced Central Receiver. This task included developing a plan to bring the commercial plant conceptual design into being. The base version of the plan includes a pilot plant to be designed and constructed during Phases II and III, three subsystem research experiments to be performed during Phase II, and the design and construction of a commercial demonstration plant. These plans are discussed in detail, as well as several options which could reduce both cost and schedule to achieve the overall goal of a commercial-sized demonstration plant. In evaluating pilot plant characeristics, emphasis was placed on representing commercial plant receiver characteristics and total system operation. In considering total system operation, it was recognized that a water-steam pilot plant would already be in operation, hence certain systems will already have been tested. Several receiver configurations were investigated consisting of from one to five full-size panels, with the objective of representing peak north side power for a 100-MWe plant as well as the peak flux vaue of about 1.4 MW/m^2. This goal was accomplished with a 5-panel receiver; however, the power to the edge panels is very low. Hence, with little loss, these panels can be eliminated to give a 3-panel configuration. The total absorbed thermal power is about 38 MWt, which is sufficient for about 10 MWe. A plant of this size is described.

30436 (SAN—1726-1(Vol.2)) **Closed Brayton cycle advanced central receiver solar-electric power system. Volume II. Evaluation, selection, conceptual design, and assessment of a closed Brayton cycle advanced central receiver solar-electric power plant with coupled sensible heat storage. Final report, September 30, 1977-November 30, 1978.** Davidson, W.S.; Kercher, C.E.; Knutson, B.W.; Kofal, A.E.; Plummer, D.F.; Roberts, J.H.; Schroeder, J.B.; Vieth, G.L. (Boeing Engineering and Construction Co., Seattle, WA (USA)). Nov 1978. Contract EG-77-C-03-1726. 603p. NTIS, PC A99/MF A01.

The performance and design requirements for one type of terrestrial solar thermal electric power system are described. Each of the system's major subsystems are analyzed in terms of concept and performance. The method of selecting the preferred commercial-scale system is described. The preferred commercial system conceptual design is described, and its technical and cost performance evaluated. Comments on the preferred commercial system from certain electric utilities are summarized. Finally, potential improvements to improve the performance and reduce the capital cost of the system are reviewed, and possible limitations to the development of the system are examined. Appendices provide details on certain analytic techniques, cost and performance data.

30437 (SAND—80-8180) **Electric power generating subsystem study for advanced water/steam receivers. Final technical report.** Oganowski, G.; Muller, D.J. (General Electric Co., Schenectady, NY (USA). Energy Systems Programs Dept.). Apr 1980. Contract AC04-76DP00789. 176p. NTIS, PC A09/MF A01.

The objective of this particular program was to evaluate the performance and economics of a range of 1985-vintage Rankine power conversion cycles for advanced water/steam solar plant application. The program output provides sufficient information for selection of the optimum power conversion cycle when integrated with other advanced water/steam solar plant systems being developed under separate Sandia contracts. The major program efforts included: cycle screening, performance analysis, and cost analysis. Each of these efforts is described in detail. A wide range of turbine cycle options was evaluated for thermodynamic performance to enable selection of cycles for detailed analysis. Cycles evaluated in the screening study included: nonreheat cycles, solar reheat cycles, and steam reheat cycles. The turbine cycle/thermal storage subsys-

tem combinations selected in the screening process were analyzed in detail over a range of nominal power outputs and throttle conditions. Trade-off studies were performed in several areas to optimize the performance of the nonreheat and reheat cycle configurations. Trade-off studies were performed in the following areas: storage subsystem pressure, number of feedwater heaters functioning during storage operation, casing configurations, single versus dual stage storage, and storage discharge flow rate. The trade-off studies resulted in cycle configurations which were analyzed by a detailed turbine analysis computer code which produced estimates of cycle performance.These results are presented. The costs of the equipment were determined for the selected turbine cycles, including the turbine-generator equipment from the inlet nozzles to the generator busbar together with the support equipment necessary to enable the turbine and generator to function. (WHK)

30438 (SAND—80-8505, pp 15-24) **Technical overview of the Solar Central Receiver Program.** Skinrood, A.C. (Sandia National Labs., Livermore, CA). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

30439 (SAND—80-8505, pp 25-47) **10 MWe Solar Thermal Central Receiver Pilot Plant.** Schweinberg, R.N. (Dept. of Energy, El Monte, CA); Reeves, J.N. Jun 1980.

In Department of Energy large solar central power systems semiannual review.

The 10-MW Solar Thermal Central Receiver Pilot Plant program at Daggett, California is described. The project schedule, activities, and construction status are discussed. (WHK)

30440 (SAND—80-8505, pp 48-60) **500 kW/sub e/ Central Receiver System (CRS) of the IEA Small Solar Power System Project (SSPS), Almeria.** Becker, M.; Grasse, W.; Kalt, A. (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e.V., Cologne, Germany). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

The Small Solar Power Systems Project (SSPS) of the International Energy Agency (IEA) consists of the design, construction, testing and operation of two dissimilar types of solar thermal power plants, each of same electrical output (500 kW/sub e/), constructed adjacent to each other on a site in Almeria, Southern Spain. Both will deliver electric energy to the Spanish grid and optionally operate in a stand-alone mode. Design requirements are derived from the intention to evaluate and to compare the relative economic viability of solar power plants using a farm-type (DCS) versus a tower-type (CRS) facility and to extrapolate future development necessities concerning technological advances and plant size optimization. Project status is described. (WHK)

30441 (SAND—80-8505, pp 84-88) **Solar Repowering/Industrial Retrofit Program element plans: draft.** Prince, L.E. (Dept. of Energy, San Francisco, CA). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

The Department of Energy (DOE) has prepared a detailed plan for Solar Repowering/Industrial Retrofit (Repowering) projects. These projects follow the 10 MW Pilot Plant at Barstow, CA on the critical path to commercialization of central receiver (CR) technology. Commercialization in the 1980's is necessary if the national goal of 1 Quad (100 million MW hrs) of fossil energy displacement by central receivers is to be achieved by the year 2000. The technical plan for repowering is outlined; repowering conceptual designs are tabulated; and a program schedule and funding estimate is given. (WHK)

30442 (SAND—80-8505, pp 205-212) **Pilot plant receiver panel testing at the Central Receiver Test Facility .** Coleman, G.C. (McDonnell Douglas Astronautics Co., Huntington Beach, CA); Friefeld, J.M. Jun 1980.

In Department of Energy large solar central power systems semiannual review.

Insolation testing has been conducted at the Central Receiver Test Facility (CRTF) at Albuquerque, New Mexico to confirm the solar receiver design for the Department of Energy's first solar thermal electric Pilot Plant at Barstow, California. The test assembly, which consisted of a receiver panel and supporting control and instrumentation hardware, essentially duplicated, both physically and functionally, one full-scale module of the external, water/steam single-pass-to-superheat solar receiver. Testing included receiver operation under all insolation and operating conditions anticipated for the Pilot Plant. Receiver steady-state and transient operating characteristics and performance were investigated during normal Pilot Plant start up, mode transitions, and shutdown sequences; during intermittent cloud conditions; and during simulated emergency situations. Test results are discussed.

30443 (SAND—80-8505, pp 213-220) **Alternate Central Receiver Power System Program: Phase II.** Elsner, J.A. (General Electric Co., Schenectady, NY). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

The Phase II program is nearing the end of its first year, having started on April 9, 1979. The program's principle activity is the design, fabrication, installation, and testing of a 2.5 MW (thermal) sodium cooled test receiver. The test receiver has a nominal outlet temperature of 1100°F and a cold leg return temperature of 600°F, typical of the reference 100 MWe commercial scale plant. Progress is reported.

30444 (SAND—80-8505, pp 221-229) **CRTF Molten salt receiver subsystem research experiment (SRE).** Tracey, T.R. (Martin Marietta Corp., Denver, CO). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

The primary objective of the receiver SRE is to demonstrate the safe and efficient operation of a thermal receiver for a central receiver power system using molten salt (60% $NaNO_3$, 40% KNO_3) under conditions similar to a commercial receiver. Project status is reported.

30445 (SAND—80-8505, pp 233-242) **Summary of final report on solar advanced steam/water receiver.** Durrant, O.W.; Wiener, M. (Babcock and Wilcox Co., Barberton, OH). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

Significant effort has been directed in recent years toward the development of central receiver, solar thermal electric power generation systems suitable for mid-term commercial use by utilities. Several major studies directed at defining preliminary designs for Rankine steam cycle systems have been conducted. More recently, emphasis has been given to individual systems within the total plant framework. The Advanced Water/Steam Receiver project was intended to yield a conceptual design (nominal 100 MWe capacity), focusing on the solar receiver (with interface considerations given to closely related plant systems), that build upon the technology base created by prior DOE projects. This summary report provides a brief review of the system concept, basic design rationale, key system features such as cost, performance and design characteristics, and important conclusions.

30446 (SAND—80-8505, pp 243-254) **Conceptual design of an advanced water-steam central receiver.** Matthews, F.T. Jun 1980.

In Department of Energy large solar central power systems semiannual review.

An advanced water/steam receiver conceptual design study has been completed by the Power Systems Group of Combustion Engineering, Inc. The program duration was 13 months, with a cost of $404,500. Specific objectives were: (1) Develop conceptual designs of Category II receivers with steam outputs ranging from 126 to 378 kg/s. (1×10^6 to 3×10^6 lb/hr). Category II is defined as pressure and temperature conditions higher than those for the Solar One Barstow Pilot Plant. (2) Develop budgetary type cost estimates for the above selected receivers. (3) Assess the design technology involved. Progress is reported.

30447 (SAND—80-8505, pp 255-264) **Conceptual design of an advanced water/steam receiver.** Gorman, D.N. (Martin Marietta Corp., Denver, CO). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

Martin Marietta Corporation and Foster Wheeler Development Corporation have teamed together under the sponsorship of the Sandia Laboratories to develop the design of an advanced water/steam receiver (AWSR). The design goal was to produce a receiver concept featuring an optimum combination of cost, performance and reliability for use in a solar thermal central power system that can meet the stringent economic and operational requirements of the commercial electric power generation market. A structured program was followed with major emphasis on the tasks of requirement specification definition, parameteric analysis of candidate concepts, selection of the preferred concept and finalization of the pertinent design, performance and economic characteristics for the receiver. Other technical tasks included were definition of interface requirements, assessment of a commercial scale AWSR power system and generation of a receiver development plan. Project status is reported.

30448 (SAND—80-8505, pp 267-270) **Heliostat development.** Eicker, P.J. (Sandia National Lab., Livermore, CA). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

Current and planned activities in heliostat design, development, and economics for tower focus power plants and process heat applications are reviewed. (WHK)

30449 (SAND—80-8505, pp 273-278) **Second generation heliostat development.** Gillette, R.B. (Boeing Engineering and Construction Co., Seattle, WA). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

Boeing Engineering and Construction (BEC) is under contract with Sandia Livermore Laboratories to design, fabricate, test and deliver two prototype heliostats. These heliostats will be installed and tested at the Central Receiver Test Facility (CRTF) in Albuquerque in late 1980. The Sandia contract also requires development of a production/installation plan and cost estimates for deploying 50,000 heliostats/yr in the southwest US. Cost estimates will also be developed for deployment rates of 25,000 and 67,500 heliostats/yr. The primary objectives of the contract are to reduce heliostat costs, and involve pertinent commercial industry to the maximum extent possible. To accomplish these objectives a design is being developed which utilizes low cost materials and processes, minimizes production costs, and minimizes field installation labor. Progress is reported. (WHK)

30450 (SAND—80-8505, pp 279-283) **Second-generation heliostat development.** Oldham, L.P. (Martin Marietta Corp., Denver, CO). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

The Martin Marietta Corporation is developing an advanced mass-producible heliostat design that will support the Department of Energy cost and technology goals of solar central receiver systems as a competitive alternative source of energy. The second-generation heliostat configuration consists of a single pedestal, a combined azimuth/elevation gear drive and approximately 612 square feet of thin second-surface glass mirrors. Figure 1 is a preliminary artist's concept. The projected reflectivity will be between 92.5 and 95.0%. Since this heliostat may be used in industrialized as well as remote desert areas, Martin Marietta has retained the inverted stow capacity. This will reduce the mirror washing frequency by minimizing the deposition of airborne material onto the mirror surface as it is condensed out of the atmosphere. Progress is reported. (WHK)

30451 (SAND—80-8505, pp 284-289) **Second generation heliostat.** Steinmeyer, D.A. (McDonnell Douglas Astronautics Co., Huntington Beach, CA). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

Under contract to Sandia Laboratories, Livermore, California, McDonnell Douglas Astronautics Company (MDAC) is developing a Second Generation heliostat. The development program includes fabrication and testing of two prototypes, conceptual design of production capability, and life cycle cost projections. Progress is summarized.

30452 (SAND—80-8505, pp 290-294) **Second generation heliostat status.** Pietsch, J.A. (Northrup, Inc., Hutchins, TX). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

The Second Generation Heliostat Development at Northrup is one of five contracts directed toward the development of unique heliostat designs which can be produced in volume at economic cost levels. The effort includes the design of a manufacturing facility, the planning of the transportation of the factory output to the installation sites, the developmant of installation procedures, and finally the projection of operating and maintenance costs. The contract requires that two production prototypes of the heliostat plus additional mirror modules be delivered to CRTF for performance evaluation and review. The results of these evaluations plus the projected costs will provide the inputs for an overall evaluation of the design. Status is reported. (WHK)

30453 (SAND—80-8505, pp 295-299) **Westinghouse second generation heliostat.** Devlin, R.W. (Westinghouse Electric Corp., Pittsburgh, PA). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

Westinghouse Electric Corporation is a participant in the Second Generation Heliostat Development Program under Sandia Contract Number 83-2729D. The scope of the contract includes: (1) design of a cost effective production heliostat; (2) preliminary design of facilities and equipment for manufacturing, transportation, installation and maintenance functions; and (3) develop cost estimates for prescribed production rates and cumulative production including operation and maintenance costs. Activities during this semiannual period consisted of finalizing the production unit design, initiating design details and procurements for prototype fabrication, and initiating manufacturing plan and cost estimates. Progress is indicated.

30454 (SAND—80-8505, pp 300-302) **Barstow Pilot Plant heliostat design.** Brown, P.R. (Martin Marietta Corp., Denver, CO). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

Martin Marietta's Collector Subsystem (CS) has been designed to meet all design and Performnace requirements for the 10-MWe Solar Thermal Central Receiver Pilot Plant. The design has evolved through 6 years of hardware fabrication, software development, field installation and test experience. The design-to-life-cycle cost approach has resulted in a no-scheduled maintenance heliostat, using conventional commercial components that can be procured from multiple sources with the advantage of competitive pricing. The CS incorporates 1818 Sunburst heliostats and an all digital control system. A representation of the major elements of the CS and their interconnections and interfaces are shown.

30455 (SAND—80-8505, pp 303-315) **Heliostat production evaluation and cost analysis.** Britt, J.F. (GM Transportation Systems Center, Detroit, MI). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

The objective of the manufacturing task was to define the technical information on materials, methods, and labor as required to conduct a manufacturing cost analysis. Each step in the fabrication and assembly of the heliostat from the initial material (raw or purchased part) through the final assembly, and packaging for shipment was addressed in accomplishing this objective. The work defined under the manufacturing task provided the basis for developing a manufacturing cost per heliostat at two selected production volumes, 25,000 heliostats per year and 250,000 heliostats per year. In addition, to provide some insight to the variability of manufacturing cost as a function of production level changes, manufacturing costs were developed for 75% and 125% of plant capacity at both the low and high standard volumes. For this study, a dedicated facility of new construction was chosen as the plant configuration for both the low and high volumes. Factors considered in defining the plant for cost analysis were geographic location, land requirements including allowance for possible expansion, available labor and supporting vendor industry, heliostat transportation requirements, material availability and the physical configuration of the building(s) necessary for an integrated manufacturing site. Results are reported. (WHK)

30456 (SAND—80-8505, pp 324-347) **Pilot plant heliostat test results.** Pignolet, C.J. (Sandia National Labs., Livermore, CA). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

A side-by-side testing concept was used to evaluate the competitive Phase I preproduction heliostat designs produced by Martin Marietta Corporation (MMC) and McDonnell Douglas Astronautics Company (MDAC) for the Barstow 10-MW/sub e/ pilot plant. An initial presentation of this test evaluation program was made by W.G. Wilson. Since test activity was still going on at the time, and the competitive situation precluded divulging test results, Wilson was constrained to giving just an overview of the test plan. Actual testing wasn't completed until early October, with final evaluation and recommendations of the Technical Evaluation Committee to the DOE Selection Panel being made in mid-October 1979. The purpose of this presentation is to summarize those testing activities. Results are presented.

DISTRIBUTED COLLECTOR

REFER ALSO TO CITATION(S) 30440

30457 (GA-A—15580) **Line focus solar central power systems. Phase I. Final report, September 30, 1978-October 31, 1979.** (General Atomic Co., San Diego, CA (USA)). Sep 1979. Contract ET-78-C-03-2240. 680p. NTIS, PC A99/MF A01.

A conceptual design study was performed of a stand-alone Line Focus Solar Central Power System based on the fixed mirror solar concentrator (FMSC) for heat collection and draw salt (a 50% molar mixture of sodium nitrate and potassium nitrate) for heat transport and storage. Parametric analyses were performed at the subsystem level, and models were developed that were employed in a computerized simulation to minimize the cost of electricity (COE) by adjusting system design parameters. A design was prepared and costed for a first commercial plant with a rating of 100 MW(e) and a storage capacity equivalent to 420 MW(e)-hr of generation. The resulting plant achieves an annual capacity of 45.6%. Scaling studies indicate reductions in the COE for increased capacity factor and increased plant rating. Assessments of the plant concept indicate it should be acceptable to utilities on the basis of technical and operational considerations, but that reductions from the first 100-MW(e) plant cost would be required to achieve substantial market penetration.

30458 (SERI/TR—631-505) **Advanced Component Research Facility (ACRES).** Bohn, M. (Solar Energy Research Inst., Golden, CO

(USA)). Jul 1980. Contract AC02-77CH00178. 36p. NTIS, PC A03/MF A01.

A detailed description of the SERI Advanced Component Research Facility (ACRES) is given. Background information explicates the facility's history, developed around the two Omnium-G parabolic dish concentrators. The Omnium-G concentrators and electrical power plant are described. The purpose and a detailed descripttion of ACRES is also given. Included is a description of the measurement capabilities, the controls, and each component of the facility.

TOTAL ENERGY AND HYBRID SYSTEMS

REFER ALSO TO CITATION(S) 30429

30459 (SAND—80-8505, pp 11-14) **Central receiver systems development.** Elliott, S.D. (Dept. of Energy, San Francisco, CA). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

The DOE program philosophy and plans for solar cogeneration plants are discussed. (WHK)

30460 (SAND—80-8505, pp 146-154) **Sierra Pacific Utility repowering.** Easton, C.R. (McDonnell Douglas Astronautics Co., Huntington Beach, CA). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

MDAC, in conjunction with Sierra Pacific Power Company, is studying the repowering of SPPCo's Ft. Churchill plant, Unit No. 1. The site is located 47 miles southeast of Reno, Nevada. The preferred system selected, which utilizes a molten salt heat transfer fluid in a tower focus power plant, is briefly described. (WHK)

30461 (SAND—80-8505, pp 155) **Southwestern Public Service Solar Repowering Program.** Elsner, J.A. (General Electric Co., Schenectady, NY). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

The Southwestern Public Service (SPS) Solar Repowering Program is a design study that will result in the conceptual design and economic assessment of a 60 MWe solar retrofit of SPS Plant X Unit No. 3, a gas-fired reheat unit rated at 100 MWe. The site of the project is south of Earth, Texas, in the Texas Panhandle, where the solar insolation reaches an attractive 940 watts per square meter. The solar installation would be located adjacent to the existing plant and would occupy about 212 acres of land already owned by SPS. Progress is reported. (WHK)

30462 (SAND—80-8505, pp 156-163) **Solar repowering system for Texas Electric Service Company Permian Basin Steam Electric Unit No. 5 sodium cooled concept.** Springer, T.H. (Rockwell International, Canoga Park, CA); Clary, G. Jun 1980.

In Department of Energy large solar central power systems semiannual review.

This conceptual design study is to determine the feasibility of repowering the existing fossil-fueled Permian Basin Unit 5 in order to save fuel (natural gas) with an advanced solar central receiver system using liquid sodium as the heat transport fluid. The solar central receiver system has a thermal power equivalent to 50 MWe and consists of a receiver absorber surface mounted on a tower which is surrounded by a field of heliostats (mirrors). As the heliostats track the sun, the solar radiation is reflected by the mirror surface to the receiver on the tower. Solar energy in the form of heat is absorbed by the liquid sodium flowing through the receiver. Liquid sodium is an excellent heat transfer fluid because of its high thermal conductivity, remains liquid for the temperature range of this application, and the sodium technology is well developed. The resulting system advantages from these characteristics of sodium are that the receiver is smaller and lighter in weight, a single-phase fluid simplifies receiver operation, reheat is readily accomplished, and thermal storage is easily incorporated as tanks of liquid sodium. With thermal storage in this manner, complete thermal buffering between the receiver and steam generator is accomplished to minimize the effects of receiver thermal transients. Unit 5 is an intermediate-load plant that employs a reheat steam cycle with a net power output of 115 MWe. The natural-gas-fired boiler (oil backup) is a single drum type and supplies 1005°F superheat steam at 1516 psia and 1005°F reheat steam at 471 psia.

30463 (SAND—80-8505, pp 164-169) **Saguaro Power Plant solar repowering project.** Weber, E.R. (Arizona Public Service Co., Phoenix, AZ). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

Arizona Public Service is engaged in a study on solar repowering of its Saguaro Power Plant Unit No. 1. The selected configuration utilizes a high temperature molten salt (60% $NaNO_3$ and 40% KNO_3) as the heat transfer and thermal storage medium. The repowered plant consists of solar and non-solar (fossil fired) portions of the plant that operate in solar stand-alone, fossil alone or parallel mode. The hot salt from storage is used to generate steam for the turbine in salt heat exchangers. For the fossil portion of the plant, oil/gas is used to fire the boiler which supplies super-heated steam to a non-reheat turbine. This repowering configuration provides a plant for the utility that has design and operational flexibility and is an economically viable resource for peaking plant operatiion. Progress is reported.

30464 (SAND—80-8505, pp 170-174) **Solar repowering Newman Unit 1.** Brown, J.E. (El Paso Electric Co., TX). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

The principal objective is to develop a conceptual design and cost estimate for solar repowering Newman Unit 1 that has the potential for construction and operation by 1985, makes use of existing solar thermal technology and provides the best economics for overall plant application. Specific objectives are: (1) prepare a Systems Requirement Specification for solar repowering Newman Unit 1, (2) select a configuration and prepare a conceptual design, (3) establish the performance and economic attractiveness of the solar repowering design, and (4) prepare a development plan for a demonstration program at Newman Station. Program status is reported. (WHK)

30465 (SAND—80-8505, pp 175-183) **Solar repowering systems Public Service Company of Oklahoma.** Levy, S.L. (Black and Veatch, Kansas City, MO). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

A site specific conceptual design for solar repowering Public Service Company of Oklahoma's (PSO) Northeastern Station Unit 1 is presented. The project objective is to develop the best site specific conceptual design that will: (1) provide practical and effective use of solar energy for repowering an electric power plant; (2) have the potential for construction and operation by 1985; and (3) make maximum use of existing solar thermal technology. The conceptual design is presented in terms of system description, rationale for selection and plant site description. (WHK)

30466 (SAND—80-8505, pp 184-192) **Solar repowering system for West Texas Utilities Paint Creek Power Station Unit No. 4 sodium cooled concept.** Springer, T.H. (Rockwell International, Canoga Park, CA); Stanaland, R. Jun 1980.

In Department of Energy large solar central power systems semiannual review.

This study established the feasibility of using a sodium-cooled solar central receiver system to repower Unit No. 4 of the Paint Creek Plant. The solar part of the plant consists of a receiver mounted on a tower. The tower is surrounded by a field of mirrors which track the sun and reflect its rays onto the receiver. Sodium is pumped through the receiver and is heated by the energy of the sun's rays. The hot sodium is pumped through a sodium-heated steam generator generating steam and a sodium-heated reheater in parallel with the existing gas-fired fossil burner. Solar energy is provided from storage to permit the sodium heated steam generator equipment to operate overnight. The plant can operate on fossil only at 110 MWe or on solar only, at 60 MWe, or on some mix between these limits. It is estimated that ~ 64 billion cubic feet of natural gas will be saved over the 30-year lifetime of the plant. Conceptual design and operation are described. (WHK)

OCEAN THERMAL GRADIENT POWER PLANTS

30467 (CONF-800633—1) **Development of OTEC lift cycles.** Chen, F.C.; Michel, J.W. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 15p. NTIS, PC A02/MF A01.

From 7. ocean energy conference; Washington, DC, USA (2 Jun 1980).

An OTEC lift cycle system may be considered an open power cycle that uses an hydraulic turbine for power generation instead of the very low pressure steam turbine used in the Claude open cycle. It offers an alternate approach to the utilization of ocean thermal energy. The lift cycle power plant can have many different system options depending on the lift process employed. Foam and mist lift processes are presently under development sponsored by the US Department of Energy and are currently in the technical feasibility development stage. The concept of lift cycles, recent developments, preliminary cost estimates, and possible further activities are presented.

30468 (CONF-800633—2) **Experimental studies of OTEC heat transfer evaporation of ammonia on vertical smooth and fluted tubes.** Mailen, G.S. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 24p. NTIS, PC A02/MF A01.

From 7. ocean energy conference; Washington, DC, USA (2 Jun 1980).

Experiments were run to determine the heat transfer performance of single vertical tubes with ammonia evaporating from a thin falling film on the tube outside. The three aluminum tubes tested were of 2.54-cm (1.0-in.) nominal diameter and 1.22-m (4.0-ft) length; one with smooth internal and external surfaces, one with a smooth inside surface and 48 external flutes, and one with 34 internal and 42 external flutes. The composite evaporation heat transfer coefficients (coefficients that include the resistance of both the evaporating film and the tube wall), based on the total tube outside surface area, ranged from 2720 to 12,020 $W/m^2.K$ (480 to 2120 $Btu/h.ft^2.°F$) over the heat load range of 690 to 3990 W (2360 to 13,620 Btu/h). Corresponding composite temperature differences ranged from 1.2 to 5.7°K (2.2 to 10.2°F). Reflux ratios, the ratio of the ammonia feed rate at the top of the tube to the average evaporation rate, ranged from 1.1 to 12.6 over the ammonia feed rate range of 3×10^{-6} to 15.9×10^{-6} m^3/s (0.05 to 0.25 gpm). The data show that fluted tubes provide little or no enhancement of evaporation-side heat transfer coefficients when compared to evaporation coefficients obtained from a smooth tube.

30469 (DOE/ET/21002—3) **OTEC support services. Quarterly technical progress report No. 8, February 15-May 14, 1980.** Lipari, M.V. (Value Engineering Co., Inc., Alexandria, VA (USA)). May 1980. Contract AC02-78ET21002. 28p. NTIS, PC A03/MF A01.

Technical engineering and management support services provided by the VSE Corporation for the Ocean Thermal Energy Conversion Program of the Ocean Systems Branch, Division of Central Solar Technology are reported. Tasks include: (1) survey, analysis, evaluation, and recommendation concerning program performance; (2) program technical monitoring; (3) development and implementation of methodology to identify and evaluate program alternatives; (4) technical assessments; (5) OTEC system integration; (6) environment and siting considerations; and (7) transmission subsystem considerations. (WHK)

30470 (DOE/NOAA/OTEC—1) **Effects of shear and roughness on vortex sheeding patterns behind a circular cylinder at critical Reynolds numbers.** Rooney, D.M.; Peltzer, R.D. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA)). Oct 1979. Contract EG-77-A-29-1078. 114p. NTIS, PC A06/MF A01.

This test program was undertaken to further the understanding of vortex shedding patterns to be experienced by the OTEC Cold Water pipe. The present series of tests was planned to incorporate improvements in design of the previously used test model and data gathering capability in order to achieve certain results which the previous program was unable to achieve. Specifically, three goals were envisioned: (1) determination of eddy shedding correlation lengths as a function of upstream shear. Improved endplate design and larger aspect ratio were the chief steps taken toward attaining this objective. (2) Determination of minimum shear level producing cellular shedding patterns. A wider range of upstream velocity shears was to be tested than in any previous study. (3) Detailed analysis of the effect of roughness on shedding patterns. A very smooth cylinder was to be tested under the same conditions as a roughened cylinder, and the two sets of results compared. Two weeks of wind tunnel testing were scheduled to perform the tests. The first week was allotted to the roughened cylinder, and the second week was devoted to examining the smooth cylinder. The experimental setup and procedures are described, and results are presented and discussed. (WHK)

30471 (DOE/NOAA/OTEC—14) **Ocean Thermal Energy Conversion Cold Water Pipe Preliminary Design Project. Final report.** (TRW Systems and Energy, Redondo Beach, CA (USA)). 20 Nov 1979. Contract EG-77-A-29-1078. 220p. NTIS, PC A10/MF A01.

NOAA/DOE has selected three concepts for a baseline design of the cold water pipe (CWP) for OTEC plants: (1) a FRP CWP of sandwich wall construction suspended from the Applied Physical Laboratory/John Hopkins University (APL/JHU) barge at a site 200 miles east of the coast of Brazil using a horizontal deployment scheme; (2) an elastomer CWP suspended from the APL/JHU barge off the south-east coast of Puerto Rico using either a horizontal or vertical deployment scheme; and (3) a polyethylene CWP (single or multiple pipe) suspended from the Gibbs and Cox spar at the Puerto Rico site using a horizontal deployment scheme. TRW has developed a baseline design for each of these configurations. Detailed designs and analyses for the FRP, polyethylene, and elastomer concepts, respectively, are described. Each section includes a discussion of fabrication plans and processes, schedules for mobilization of facilities and equipment, installation plans, and cost breakdown. (WHK)

30472 (SAN—1570-2/3) **Power system development: Ocean Thermal Energy Conversion (OTEC). Preliminary design report: appendices, Part 2 (Final).** (TRW Systems and Energy Group, Redondo Beach, CA (USA)). 4 Dec 1978. Contract EG-77-C-03-1570. 494p. NTIS, PC A21/MF A01.

The objective of this project is the development of a preliminary design for a full-sized, closed cycle, ammonia power system module for the 100 MWe OTEC demonstration plant. In turn, this demonstration plant is to demonstrate, by 1984, the operation and performance of an Ocean Thermal Power Plant having sufficiently advanced heat exchanger design to project economic viability for commercial utilization in the late 1980's and beyond. Included in this power system development are the preliminary designs for a proof-of-concept pilot plant and test article heat exchangers which are scaled in such a manner as to support a logically sequential, relatively low-cost development of the full-scale power system module. The conceptual designs are presented for the demonstration plant power module, the proof-of-concept pilot plant, and for a pair of test article heat exchangers. Costs associated with the design, development, fabrication, checkout, delivery, installation, and operation are included. The accompanying design and producibilty studies on the full-scale power system module project the performance/economics for the commercial plant. This section of the report contains appendices on the electrical system, instrumentation and control, ammonia pump evaluation study, ammonia and nitrogen support subsystems, piping and support design calculations, and plant availability. (WHK)

SOLAR RADIATION UTILIZATION

REFER ALSO TO CITATION(S) 30528, 30540

SPACE HEATING AND COOLING

REFER ALSO TO CITATION(S) 30529, 30539, 30542, 30795

30473 (CONF-780249—) **Use of solar energy for the cooling of buildings.** Clark, E.F.; de Winter, F. (eds.). (Altas Corp., Santa Cruz, CA (USA)). Oct 1978. Contract EG-77-C-02-4576. 393p. NTIS, PC A17/MF A01.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

Separate abstracts were prepared for the 46 papers included. (WHK)

30474 (CONF-780249—, pp 3-13) **Overview of the national solar cooling.** LeChevalier, R.R. (Dept. of Energy, Washington, DC). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

The DOE development and demonstration program for stimulating the rapid commercialization of solar cooling systems is described. The available technology options are discussed and prioritized. (WHK)

30475 (CONF-780249—, pp 14-18) **Overview of absorption cooling technology in solar applications.** Auh, P.C. (Brookhaven National Lab., Upton, NY). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

The general operation, performance, and commercial availability of solar absorption chillers are discussed. The DOE RD & D program concerning solar absorption chillers is reviewed. (WHK)

30476 (CONF-780249—, pp 19-22) **Development of unitary solar heating/cooling packages.** Merrick, R.H. (Arkla Industries Inc., Evansville, IN). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

A residential-sized unitary solar heating/cooling system incorporating a 3-ton direct evaporatively cooled Arkla chiller is described. Plumbing features and operating features are discussed, and system schematics are included. (WHK)

30477 (CONF-780249—, pp 23-28) **Development of a single family absorption chiller for use in a solar heating and cooling system.** Biermann, W.J. (Carrier Corp., Syracuse, NY). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

The program includes the selection of a most promising candidate absorbent-refrigerant-additive chemical system for heat rejection directly to ambient air, collection of necessary basic design data, design and construction of a single family residential sized air conditioner (about 10 kW cooling) and testing under a variety of specified conditions. Much of the system selection data will be drawn from unpublished data collected by the Research Division, Carrier Corporation, in connection with direct gas fired, air cooled absorption chiller program carried out previously. Considerable reworking of this data is required for evaluation in terms of the operating conditions at present defined by the contract; i.e., 230°F solar water, 95° air, 45°F chilled water. Progress is reported. (WHK)

30478 (CONF-780249—, pp 29-34) **Prototype energy retrieval and solar system.** Biermann, W.J. (Carrier Corp., Syracuse, NY). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

This is an applied research project intended to develop and test two items of prototype equipment in a retrofit installation on the Ross Control House, Vancouver, Washington. These items are: (1) a heat pump device to recover low grade thermal energy from a 250 MVA transformer cooling oil circuit for use in space heating; and (2) an absorption chiller designed for low temperature operation. The installation was completed in mid-January 1978 and is now being used for indoor climate control for the 2500 sq ft space. The systems are described.

30479 (CONF-780249—, pp 35-37) **Development of solid-phase absorption air conditioner with built-in storage.** Offenhartz, P.O'D. (EIC Corp., Newton, MA). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

A complete solar air-conditioning system consists of four major components: collector; air-conditioner; storage subsystem; and heat rejection subsystem. A major problem is system development in the integration of these components. For example, choice of the heat rejection system (e.g., forced air, humidified air, or cooling tower) has an important influence on the choice of collector; choice of the underlying chemistry in the air-conditioner affects both collector and heat rejection choices; short-term air-conditioner performance determines the need for cold-side (in addition to hot-side) storage. At EIC Corporation, the approach to this problem has been to design systems that combine air-conditioning and storage in a single chemical reaction.

30480 (CONF-780249—, pp 39-46) **Solar powered residential air conditioning by lithium bromide absorption systems at Colorado State University.** Conway, T.M.; Loef, G.O.G. (Colorado State Univ., Fort Collins). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

Three solar powered lithium bromide absorption cooling systems have been employed at Colorado State University Solar Houses I and III. A modified charge Arkla Solaire Model 501-WF 10.5 kW (38 MJ/hr, 3-ton) unit was installed in Solar House I in early 1974. It was coupled with the CSU liquid flat-plate collector system and a Marley model 4615, 28.1 kW (101.3 MJ/hr, 8-ton) water cooling tower. The system operated during the 1974, 1975, and 1976 cooling seasons. In the winter of 1976, the later model Arkla Solaire WF-36 lithium bromide absorption water chiller replaced the original unit and was coupled with the high performance Corning Glass Works evacuated tube collector and the same Marley model 4615 cooling tower. This system provided cooling during the 1977 cooling season. The third lithium bromide absorption cooling system at Colorado State University Solar Energy Applications Laboratory is the Yazaki Corporation WFC-600S 7 kilowatt (2-ton) chiller coupled with the Owens-Illinois evacuated tube collector on Solar House III and a Yazaki CT-560 18.6 kilowatt (5.3-ton) cooling tower. Conclusions drawn from operating experience and brief descriptions of these systems and their performance are presented.

30481 (CONF-780249—, pp 47-54) **Double effect absorption cooling with solar energy.** Vliet, G.C.; Saiidi, M.J. (Univ. of Texas, Austin). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

Double effect absorption cooling systems offer a good choice for solar cooling at the higher temperatures for which Rankine cycle solar cooling is being considered. Although not well known nor widely used, there has been development of prototypes and limited production of modest capacity units and large tonnage units are commercially available. Since the coefficient of performance of the double effect absorption cycle can realistically be as high as 1.3 under steady state design conditions, this cycle should be seriously considered for future solar cooling applications.

30482 (CONF-780249—, pp 55-66) **Solar cooling projects in the commercial demonstration program; summary.** Doering, E.R. (Dept. of Energy, Washington, DC). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

The Solar Heating and Cooling Demonstration Act of 1974, P.L. 93-409 states that the purpose is to provide for the demonstration within a three-year period of the practical use of solar heating technology, and to provide for the development and demonstration within a five-year period of the practical use of combined heating and cooling technology. The strategy employed to accomplish the purpose has been to carry out several cycles of projects in which the various solar heating and cooling technologies will have been demonstrated in various building types in various climatic regions of the country, before the end of 1979. To date, February 1978, in the commercial or non-residential building category, which is managed directly by the Department of Energy (DOE). There are 181 projects in the non-federal (private and public) sector and 40 projects in the federal sector, for a total of 221 projects. There are 42 projects with solar cooling in the non-federal sector and 13 in the federal sector, for a total of 55 solar cooling demonstration projects in the solar heating and cooling of buildings program. A listing of the cooling projects by project source and location is given, and the major features associated with each project are included. Status of the program is reviewed. (WHK)

30483 (CONF-780249—, pp 67-87) **Overview of solar cooling systems which utilize adsorption/desorption processes.** Shelpuk, B. (Solar Energy Research Inst., Golden, CO). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

The technology on which existing adsorption cooling systems are based is described. It is shown that to develop viable desiccant systems a low pressure loss drier bed will be required to reduce parasitic power. Low temperature operation of the system becomes possible if the drier can be regenerated isothermally. It is also shown that closed cycle adsorption cooling systems represent a practical solar cooling alternative which has the additional capability of thermal storage or heat pumping. In both alternatives the need for proper application criteria and control strategy is emphasized. (WHK)

30484 (CONF-780249—, pp 83-89) **Development of a solar desiccant dehumidifier.** Gidaspow, D.; Lavan, Z.; Onischak, M.; Perkari, S. (Illinois Inst. of Tech., Chicago). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

A novel desiccant cooling scheme is proposed that offers significant inherent advantages. It consists of a cross-cooled dehumidifier constructed of paper-like sheets of silica gel. Detailed calculations have shown that regeneration temperatures below 180°F (in conjunction with cross-cooling) results in sufficient dehumidification for air conditioning applications. The low regeneration temperature permits the use of flat plate solar collectors. If these collectors will indeed be utilized for both heating and cooling, their economics, and hence, utilization will be vastly enhanced. Under the present program we plan to design, construct and test an entire solar energy cooling system using the dehumidifier scheme described.

30485 (CONF-780249—, pp 90-107) **Simulation of air based solar desiccant cooling systems.** Oonk, R.L.; Shaw, L.E.; (Solaron Corp., Denver, CO); Cash, M. Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

Several combined air based solar heating and solar/desiccant cooling systems were analyzed on a digital computer using TRNSYS and associated silica gel desiccant models originally developed by P.J. Banks, I.L. Maclaine-Cross and D.J. Close in Australia. In all, four desiccant cooling cycles were simulated using cooling season only data for New York City. These cycles included one which provided the house 100% ventilation air, and three cycles involved recirculation. Results from these simulations indicated that the simple recirculation ctcle gave the best overall system performance for the New York site. This cycle was then simulated for one entire year and the results compared to a solar heating system with a heat pump used as a back-up heat supply and primary cooling system. Results showed that the conventional vapor-compression heat pump consumed less electricity for heating and cooling than the solar/desiccant system.

30486 (CONF-780249—, pp 108-115) **Simulations of the performance of open cycle solar-desiccant systems.** Mitchell, J.W.; Beckman, W.A.; Nelson, J.S. (Solar Energy Lab., Madison, WI). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

A feasibility study of open cycle air conditioning systems that use solid desiccants and solar energy has been conducted. Seasonal simulations were performed for the Miami, FL, climate for two system configurations. These are the ventilation mode, in which ambient air is continually conditioned and introduced into the room space, and the recirculation mode, in which room air is reconditioned and recirculated. The sensible and latent cooling loads were those of a typical, well insulated residence. The desiccant systems used rotary dehumidifiers and sensible heat exchangers together with evaporative coolers to meet the sensible and latent loads for the house. The solar system used water as the collection medium and a tank for storage. A heat exchanger located between the collection loop and the air stream provided heat for regeneration of the desiccant, with auxiliary heat supplied, as required. The auxiliary energy requirement for the ventilation mode was found to be about one-half that for the recirculation mode for the combination of design parameters considered. The seasonal COP for the system based on total energy supplied is approximately 0.75. For a solar

system that meets about 90 percent of the cooling load, the seasonal COP based on auxiliary and parasitic power is about 5. The significant ideas involved in the design, control, and operation of the system are discussed.

30487 (CONF-780249—, pp 116-121) **Performance and potential of a desiccant cooling/heating system.** Rush, W.R.; Staats, W.R. (Inst. of Gas Tech., Chicago, IL). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

In 1975, ERDA (now DOE) and the American Gas Association jointly funded a program whose goal was the field testing of a solar desiccant system for both cooling and heating. The particular system is known as the Solar-MEC unit. The concept is the property of the Gas Developments Corporation, a wholly-owned subsidiary of the Institute of Gas Technology. The field test site was provided by the Southern California Gas Company in the City of Industry, several miles east of Los Angeles. The building chosen for the test was a field-service building and is typical of the structures used by many gas companies to provide an operations center for their service people. The section of the building requiring comfort control had been previously cooled in the summer by a three-ton, Whirlpool gas-fired air conditioner. The gas-fired unit was removed and a nominal 2-1/2-ton Solar-MEC unit was retrofit into the existing air distribution system. In addition, 600 ft^2 of the Owens-Illinois evacuated tube solar collector were installed as well as 1000 gas of aboveground storage. The collector fluid was water. Test results are presented and discussed. (WHK)

30488 (CONF-780249—, pp 122-131) **Preliminary design of a solar desiccant air conditioner.** Rousseau, J.; Hwang, K.C. (AiResearch Manufacturing Co. of California, Torrance). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

The results of preliminary design studies conducted to define and characterize a baseline dehumidifier that uses granular silica gel as a desiccant are presented. The design of a desiccant air conditioner involves the optimization of a number of parameters that define the sorbent bed and regenerator geometry and the conditions of system operation. The complex heat and mass transfer phenomena occurring in the desiccant bed and bed interaction with the process air stream require the use of sophisticated computer techniques to perform the numerous iterations necessary for the development of a design. The approach taken in the evolution of the air conditioner was to design for a reasonable COP; also, system pressure drop as it relates to electrical energy consumption was a primary consideration.

30489 (CONF-780249—, pp 132-137) **Overview of the DOE passive cooling program.** Martin, M. (Lawrence Berkeley Lab., CA). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

Three fundamental passive cooling principles are available and under suitable circumstances they can be used separately or in combination: radiative cooling to the night sky, evaporative cooling, and convective cooling. These principles may be applied with thermal storage (short term or seasonal) to displace some or all of the space cooling requirements of buildings. These three methods are not equally applicable to all parts of the country. Arid desert regions typically experience large diurnal temperature changes, whereas these fluctuations can be very small in more humid and overcast parts of the country. The DOE Passive Cooling Program, which is presently being integrated into the passive Program Plan, addresses two aspects of passive cooling (1) assessment of the cooling resource, and (2) development of passive components and system design. DOE projects are described. (WHK)

30490 (CONF-780249—, pp 138-153) **Natural cooling: practical use of climate resources for space conditioning in California.** Bainbridge, D.A. (Passive Solar Design, David, CA). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

Natural cooling can use any or all of the five basic methods for cooling: solar control, convective cooling, conductive cooling, evaporative cooling, and radiative cooling. Each of these are discussed in detail. A discussion of integrated design for natural cooling is given, and the use of natural cooling for peak load reduction in California is discussed. (WHK)

30491 (CONF-780249—, pp 154-163) **Air conditioning by nocturnal evaporative cooling of a pebble-bed.** Karaki, S.; Armstrong, P.R. (Solar Energy Applications Lab., Fort Collins, CO). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

The solar space heating system in Solar House II at Colorado State University consists of 67.1 m^2 of air-heating collectors, a pebble-bed storage that is sized at 0.153 cubic meter per square meter of collector on a gross area basis, a single blower for heat collection and distribution to the house, and an auxiliary gas furnace. The domestic hot water subsystem incorporates an air-water heat exchanger, circulation pump, and a preheat tank. A standard gas-fired auxiliary hot water tank is also provided. The nocturnal cooling system consists of an evaporative cooler and the same pebble bed used for heat storage during the heating season is used for cold charge during the cooling season. An electronic controller automatically regulates operation of the entire system. Operating modes, control logic, and system performance are discussed. (WHK)

30492 (CONF-780249—, pp 177-185) **Overview of solar Rankine cooling.** Curran, H.M. (Hittman Associates, Inc., Columbia, MD). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

The operation and performance of solar Rankine engines for cooling are discussed, and DOE's solar Rankine cooling projects are listed. (WHK)

30493 (CONF-780249—, pp 186-191) **Advanced integrated Rankine/Rankine solar heating and cooling system.** McDonald, G. (AiResearch Manufacturing Co. of California, Torrance). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

System operation and performance are described. In the heating mode, it operates as a heat pump to raise the temperature level of the solar-heated water to a higher level for space heating. In the cooling mode, solar thermal energy is used in a Rankine cycle to produce shaft horsepower to drive the compressor of a reverse Rankine cycle refrigeration system. Diagrams of the system are included. (WHK)

30494 (CONF-780249—, pp 192-198) **Rankine cycle solar driven heat pump development.** Graf, J.C. (General Electric Co., Philadelphia, PA). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

Research and development by General Electric on solar Rankine cycle-driven heat pumps for solar heating and cooling of buildings is outlined. (WHK)

30495 (CONF-780249—, pp 199-200) **Solar heating and cooling systems design and development 404.** Merrill, G.L. (Honeywell Inc., Energy Resources Center, Minneapolis, MN). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

Honeywell entered into a contract agreement with NASA Marshall Space Flight Center in July of 1976 to design and develop solar heating and cooling systems which would have high performance, low cost, be modular in application with size adaptability and be developed to a marketable state. The contract calls for delivery of the following systems: 2 - Residential heating only; 2 - Residential heating/cooling; 1 - 25-Ton Multifamily heating/cooling; 1 - 25-Ton commercial heating/cooling; 1 - 50-Ton commercial heating/cooling; and 1 - 75-Ton commercial heating/cooling. One residential heating system is operational, the second is under construction and the remaining systems are in various stages of design. The systems utilize the Lennox flat plate collector with anti-reflective glass and selective coating. System designs utilize energy directly from the collectors to the space heating coils or directly to the Rankine-driven cooling units with storage for excess energy. The systems are designed to minimize parasitic power consumption by careful design and utilization of high-efficiency pumps and electrical components. Progress is outlined. (WHK)

30496 (CONF-780249—, pp 201-207) **Analysis and design of an 18-ton solar-powered heating and cooling system.** Biancardi, F.R. (United Technologies Research Center, East Hartford, CT); Young, P. Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

The preliminary design of a Rankine-cycle turbocompressor heat pump system with attractive performance in both the heating and cooling modes is described. The system incorporates a number of features to provide low maintenance, efficient and yet versatile operation. Annual system performance is predicted to permit more than half of the total building heating and cooling energy needs to be supplied from solar energy even with a modest quantity of collectors. Concentrating collectors which can capture some diffuse radiation are shown to be superior to the other types investigated.

30497 (CONF-780249—, pp 208-228) **Design, fabrication and testing of a 77-ton solar powered water chiller for the National Security and Resources Study Center at Los Alamos, New Mexico.** Barber, R.E.; Dillard, J.E. Jr. (Barber-Nichols Engineering Co., Arvada, CO). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

The design of a 77-ton Rankine cycle water chiller was made to match the LASL flat plate solar collectors. The design solar water temperature is 200°F, cooling water temperature is 65°F, and the chilled water supply temperature is 45°F. The selected approach was to purchase a York OTA3A3 centrifugal water chiller system and couple a turbine directly to the compressor shaft. Conventional refrigeration heat exchangers were used for the boiler and condenser, and a special Barber-Nichols feed pump make up the major components of the Rankine cycle. At the design point the predicted system coefficient of performance is 0.85. The unit was fabricated and testing began in early May 1977. Loss of oil from the turbo-compressor to the evaporator delayed final performance testing until mid-August when the unit was delivered to LASL with 65 hours of test time. The design point tests showed that the unit performance exceeded the predicted values in both capacity (86 tons measured, 77 tons predicted) and coefficient of performance (COP) (.92 measured, .85 predicted). Results are presented and discussed.

30498 (CONF-780249—, pp 229-233) **Initial operation and performance of a Rankine chiller and an absorption chiller in the National Security and Resources Study Center.** Hedstrom, J.C.; Murray, H.S.; Balcomb, J.D. (Los Alamos Scientific Lab., NM). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

The Study Center is a building with 60,000 ft² of heated space that houses the laboratory main libraries and provides a study area for visiting personnel. The building is solar heated and cooled with an 8000 ft² array of flat plate collectors facing south in one plane forming the roof of the equipment room. The collectors have a selective surface of black chrome and are single-glazed with water-white glass. A paraffinic oil is used as the collector coolant which transfers heat to water through a heat exchanger. In the cooling mode hot water is stored in a 5000 gallon pressurized tank and chilled water is stored in a 10,000 gallon tank. Two water chillers are now installed in the equipment room - one a conventional York lithium-bromide absorption unit (ES1A2) derated to 85 tons with 185°F hot water, and the other a Rankine unit designed and fabricated by Barber-Nichols. The design point for the Rankine unit was 77 tons with 200°F hot water. The solar energy system has been in operation since March 1977. A 40-channel Hewlett Packard data acquisition system was installed on a temporary basis in June 1977 and was operating in August. A PDP 11/34 mini-computer has now been installed and has been operating snce December 1977. Performance data are given.

30499 (CONF-780249—, pp 234-236) **Solar steam engine for Rankine cooling.** Martin, C.G.; Kolenc, T. (Energy Tech. Inc., Cleveland, OH). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

ETI'S current contract with DOE is for the demonstration of a steam turbine air conditioning prime mover operating on a simulated solar-Rankine cycle. The turbine is a multi-stage radial outflow (ROF) design which has been under development at ETI for the past six years. A schematic diagram of the turbine is shown. Progress is reported.

30500 (CONF-780249—, pp 237-247) **Biphase solar cooling systems.** Amend, W.E. (Biphase Energy Systems, Santa Monica, CA). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

Solar cooling can be achieved by Rankine-powered vapor compression, absorption or dessicant processes. The performance of all three systems is projected to be at about the same level and all three systems require complex and expensive auxiliary power and/or energy storage units. The Biphase turbine offers an alternative prime mover for the vapor-compression system that promises higher performance, longer life, lower cost and a cheaper and simpler auxiliary power systems without energy storage. In conventional vapor-compression systems, electric motors rotating at 1800 to 3600 rpm are used to drive the compressor. The Biphase turbine is a new type of turbine that has a high torque and low shaft speed that can correspond directly to the compressor speed. Thus the problem of matching the speeds of the prime mover and the compressor is eliminated. In addition a synchronous motor can be directly connected to the turbine output shaft to supply auxiliary power. Detailed mathematical description of two promising Biphase refrigeration cycles were developed and programmed on the computer (all known first-order irreversibilities were accounted for). Extensive parameter sweeps were made to identify the most effective working-fluid combinations and to determine the sensitivity of cycle-performance levels. Finally the projected performance of the two cycles has been bracketed to show that the Biphase Systems do have higher potential COP's than the absorption units.

30501 (CONF-780249—, pp 248-259) **Solar assisted heat pump system for year-round space conditioning.** Andrews, J.W.; Kush, E.A.; Metz, P.D. (Brookhaven National Lab., Upton, NY). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

A research program to develop a cost effective solar assisted heat pump system is described. Two areas are being studied closely: (1) the redesign of the vapor compression heat pump for optimum performance with a solar heat source, and (2) the design of low-cost special collectors for use with heat pumps. Performance results of a solar assisted heat pump system modeled with the computer program TRNSYS are presented and discussed. (WHK)

30502 (CONF-780249—, pp 260-279) **Hybrid photovoltaic/thermal solar energy systems.** Kern, E.C. Jr.; Russell, M.C. (M.I.T. Lincoln Lab., Lexington, MA). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

Heating and cooling systems that use hybrid solar energy collectors (combination photovoltaic-thermal) have the potential for considerable energy savings, particularly when the system includes a heat pump. Economic evaluations show that photovoltaic systems are potentially most economical, but results depend critically on future collector costs as well as energy prices. Results are based on a specially developed computer program that predicted the total auxiliary energy required for five different solar heating/cooling systems. Performance calculations for a modeled residence and small office building were made using meteorological data from four geographic locations. Annual system costs were also calculated.

30503 (CONF-780249—, pp 280-282) **Lessons learned from heat pump marketing.** Cole, M.H. (Associated Inst. of Public Administration, Tampa, FL). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

An analysis of the marketing problems experienced by the heat pump when it was introduced twenty-five years ago reveals some interesting facts. First, it is obvious that the solar cooling products will encounter the same problems when they reach the market in the 1980's. Second, although the heat pump experienced some serious problems, the industry and its distribution channel have solved them in an acceptable manner. There are many similarities between heat pumps and solar cooling products and their interface to distribution and the ultimate user. Some of these similarities are discussed to show that solar cooling marketing is enough like heat pump marketing that they should learn from the heat pump industry's mistakes.

30504 (CONF-780249—, pp 283-287) **Structure of the solar cooling market.** Franks, L.; Fousel, D.A. (Inst. of Public Administration, Washington, DC). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

The Department of Energy plans to commission a coordinated series of market studies for solar cooling beginning late in FY 1978, to provide information needed by managers in both the public and private sectors. In the meantime, DOE requested the Institute of Public Administration to develop, in consultation with experienced HVAC marketers, a preliminary assessment of the size and structure of the potential solar cooling market in this country. A summary of some of the basic findings of this preliminary market assessment is presented. (WHK)

30505 (CONF-780249—, pp 288-289) **Marketing complete solar-HVAC systems.** Gilles, T.C. (Lennox Industries Inc., Marshalltown, IA). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

Although circumstances related to the capital intensive characteristic of solar source air conditioning systems and relatively low cost of conventional alternate energy systems presently prohibit normal marketing activity for solar source air conditioning, it is important to recognize the elements that will create a future solar source air conditioning market and the special attention needed to serve such a market in the future. This discussion addresses such subjects as: what are the requirements for producing a solar source air conditioning market, what are some of the technological alternatives, what are the needs for effective marketing, what steps will be taken during the marketing phase, and finally, what after sale activities will be required to properly service such a market?

30506 (CONF-780249—, pp 307-309) **Controllers and control strategies for solar heating and cooling systems.** Wahlig, M. (Lawrence Berkeley Lab., CA). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

Brief descriptions of DOE-sponsored projects on optimization of control strategies and equipment for solar heating and cooling systems are presented. (WHK)

30507 (CONF-780249—, pp 313-314) **Performance monitoring of solar cooling systems.** Purcell, G.G. (Electric Power Research Inst., Palo Alto, CA). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

The EPRI Solar Program is developing a preferred system approach for residential and commercial space conditioning systems. A preferred space conditioning system, from the standpoint of the electric utility and the consumer, is one that minimizes the total life-cycle cost of meeting the energy needs for a building. The design of such a system involves a stepwise approach involving consideration of: (1) energy conservation measures applied to the building structures and heating, ventilating and cooling equipment; (2) control of electric demand by load management techniques, and (3) installation of a solar system to displace energy resources. Progress is reported.

30508 (CONF-780249—, pp 315-319) **Impact of solar cooling systems on the electric and natural gas utilities.** Jardine, D.M. (Kaman Sciences Corp., Colorado Springs, CO). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

There are several factors that must be recognized and treated properly in conjunction with moving solar cooling systems towards commercialization. Life cycle costing is a valid means of determining economic impact for various applications. Life cycle costing consists of the following three elements: owning costs, operating costs, and maintenance costs. It is the purpose of this paper to present a comparison of operating costs for the lithium bromide absorption refrigeration cycle and the vapor compression refrigeration cycle as related to commercial electric power and natural gas, and to determine what the effect of employing solar energy as an energy source for operating these cycles will be insofar as operating costs are concerned.

30509 (CONF-780249—, pp 320-326) **Novel control strategies for solar assisted heating and cooling systems.** Lorsch, H.G. (Franklin Inst. Research Labs., Philadelphia, PA). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

Control strategies for using thermal storage systems with solar heating and cooling systems to reduce utility peak demands are discussed. (WHK)

30510 (CONF-780249—, pp 327-333) **Effect of solar absorption cooling on the peak loads of electric utilities.** Feldman, S.L.; Wirtshafter, R. (Russell Sage Foundation, New York, NY); Wessler, E.; Anderson, B. Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

In general, the potential effect of solar cooling may warrant close examination by public utilities. Despite the hypothesis put forth that the solar-utility interface is a relatively unimportant issue, this study indicates that the sensitivity of utility load curves to solar design is fairly high. No general statement can be made regarding the impact of solar heating and cooling upon the load curves of the electric utility industry. Variations in the ambient weather conditions, load curves and generation mixes of utilities will be the prime determinants in the magnitude of the impact. The interplay between the marginal sizing of storage and collectors, as well as specification of the passive building design elements, is crucial at the interface. The implications of solar as a load management tool seems apparent. In this context, some optimum sizing algorithm should be pursued wherein the long-run incremental cost of the solar building system should be equated with that of utility fuel and capacity.

30511 (CONF-780249—, pp 334-338) **Systems analysis of solar cooling process for residential systems.** Beckman, W.A.; Duffie, J.A.; Klein, S.A.; Mitchell, J.W. (Univ. of Wisconsin, Madison). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

The nature of solar processes is such that it is not possible to consider cooling methods alone without also considering the system and the circumstances in which it is to operate. Simulations and design procedure based simulations are powerful tools to study new cooling processes and applications in a system context. TRNSYS, developed at the University of Wisconsin, is one of the more widely used solar process simulation programs and has been used in simulation studies of several types of solar cooling systems. TRNSYS and TRNSYS-like programs are also the basis of design procedures which can (with varying degrees of validity) be used to approximate the long term thermal performance of some solar cooling systems.

30512 (CONF-780249—, pp 339-355) **Solar powered Rankine cycle/vapor compression cycle modeling and performance prediction.** Allen, R.W.; Anand, D.K. (Univ. of Maryland, College Park). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

In 1973-74, a 200°F Rankine cycle/vapor compression cycle (RC/VCC) cooling system was demonstrated. Since that time, Rankine cycle cooling activity has increased with the award of major R & D contracts. Much of the RC/VCC work has centered on design, manufacture and testing. Although worthwhile comparative evaluations of solar cooling systems may be conveniently carried out with solar heating and cooling systems simulations such as TRNSYS, publication of studies dealing with simulation of the RC/VCC subsystem has, to some extent, been neglected. There are in existence, of course, unpublished proprietary subsystem simulations. A sample RC/VCC subsystem simulation and typical results are described. A double-loop R-114/R-22 cycle investigation is conducted in which heat transfer equations, rotating component performance equations, thermodynamic cycle equations, and external fluid (water) equations are coupled and solved. Two simulations are carried out. The first is a design simulation in which the effect of heat transfer component size and temperature design point selection is studied. The second is an off-design simulation in which a prescribed design is caused to float to an equilibrium level of performance and capacity consistent with the imposed water temperature and flow rates.

30513 (CONF-780249—, pp 356-360) **Solar cooling simulation studies.** Anand, D.K.; Allen, R.W. (Univ. of Maryland, College Park). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

The solar cooling simulation studies have three primary purposes, viz. to predict daily and seasonal cooling system performance, to analyze cooling systems operating under various control strategies, and finally to conduct optimization studies. In order to conduct these studies, a computer program has been generated that can be used for predicting system performance using real and synthetic (or stochastic) weather data. This option has been specifically added so that a new scheme of system performance prediction using stochastic weather data can be studied further. In general, solar thermal systems have been analyzed for a specific control strategy that is based on experience. In the present study, however, it is possible to analyze system performance as a function of different control strategies. The various strategies appearing in the simulation have been formulated by a logical analysis of the operation of the solar system with the end view of maximizing solar energy usage and minimizing the usage of auxiliary energy. It is, however, also possible to employ other novel strategies that can be formulated by the user.

30514 (CONF-800828—1) **Performance of the biose cascade-INEL manufactured solar home.** Lau, A.S.; Liebelt, K.H.; Scofield, M.P.; Shinn, N.R. (Idaho National Engineering Lab., Idaho Falls (USA); Boise Cascade Corp., ID (USA)). 1980. Contract AC07-78ID01570. 5p. NTIS, PC A02/MF A01.

From Solwest; Vancouver, British Columbia, Canada (6 Aug 1980).

Two manufactured active solar homes using air collectors and rock storage were designed, bult and are being tested. The cooperative, DOE-funded project involves. Boise Cascade Corporation and the Idaho National Engineering Laboratory (INEL). The two primary goals of the project are to develop an active solar heating system that is cost-effective now, and to provide significant market penetration through the involvement of Boise Cascade, a major manufacturer of factory built houses. A brief discussion of the houses and solar systems is included, with more detailed discussion of the desktop-computer based data acquisition system and initial performance results. The 1979 cooling season data indicated a need for modifications to achieve adequate cooling system performance. Data from the heating season showed good agreement with calculations, especially the house heat loss coefficient. However, solar heating fractions were lower than predicted and an examination of the collector operating efficiency showed the collector losses to be approximately three times higher than predicted. Tests are underway to better understand the large collection losses. Comparison of the performance data and f-chart predictions shows significant differences, with predicted solar fractions being lower than actual. The solar domestic hot water preheating system performed reasonably well, with significant thermal losses noticed from the auxiliary hot water heater. Recommendations are made for the design of solar air-heating systems.

30515 (DOE/NASA/CR—161443) **Solar heating and hot water system installed at Municipal Building Complex, Abbeville, SC. Final report.** (National Aeronautics and Space Administration, Huntsville, AL (USA). George C. Marshall Space Flight Center). Nov 1979. Contract EM-78-F-01-5202. 55p. NTIS, PC A04/MF A01.

Information is provided on the solar energy system installed at the new Municipal Building for the City of Abbeville, SC. The information consists of description of solar energy system and building, photographs, system performance, operation manual, as-built drawings, lessons learned and recommendations. The solar space heating system is a direct air heating system. The flat roof collector panel was sized to provide 75% of the heating requirement based on an average day in January. The collectors used are job-built with

two layers of filon corrugated fiberglass FRP panels cross lapped make up the cover. The storage consists of a pit filled with washed 3/4" - 1 1/2" diameter crushed granite stone. The air handler includes the air handling mechanism, motorized dampers, air circulating blower, sensors, control relays and mode control unit. Solar heating of water is provided only during those times when the hot air in the collector is exhausted to the outside.

30516 (DOE/NASA/CR—161471) **Solar energy system performance evaluation. Seasonal report for Contemporary-Manchester, Manchester, New Hampshire.** (International Business Machines Corp., Huntsville, AL (USA). Federal Systems Div.). Jun 1980. Contract AC01-77CS34049;AI01-76CS31037. 80p. NTIS, PC A05/MF A01.

The solar energy system was designed to provide space heating and domestic hot water (DHW) preheating for a three-story dwelling located on the New Hampshire Vocational Technical College campus, Manchester, New Hampshire. The systems consist of twenty double glazed flat plate roof mounted warm air collectors (area 805 square feet) mounted with a tilt angle of 60 degrees from the horizontal, a 720 cubic foot horizontal rock bin for thermal storage, a central air handler, an 80 gallon DHW preheat tank, pumps, controls, plumbing and associated air ducting. Hot water pre-heating is accomplished by an air-to-water heat exchanger with auxiliary energy provided by conventional electric 80 gallon hot water tank. Auxiliary space heating is provided by a 112,000 Btu per hour, 1200 cubic feet per minute oil fired furnace. The analysis is based on instrumented system data monitored and collected for at least one full season of operation.

30517 (DOE/ET/20090—5) **Proposed SOLCOST maintenance activities.** (Solar Environmental Engineering Co., Inc., Fort Collins, CO (USA)). [nd]. Contract AC02-77ET20090. 17p. NTIS, PC A02/MF A01.

This document provides a short description of work that has been accomplished to date and work in progress. A discussion of the program status as it is currently configured follows and finally proposed work by Solar Environmental Engineering Company (SEEC) in its most recently signed contract with the Department of Energy (DOE) is given. Early statements are designed to give the reader a good background so that the suggested SOLCOST maintenance activities will be more easily understood.

AGRICULTURAL AND INDUSTRIAL PROCESS HEAT

REFER ALSO TO CITATION(S) 30063

30518 (SAND—80-8505, pp 91-96) **Solar thermal enhanced oil recovery.** Gorman, D.N. (Martin Marietta Aerospace, Denver, CO). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

The Martin Marietta Corporation, Exxon, Foster Wheeler Development Corporation and Black and Veatch Consulting Engineers are developing a conceptual design for a central reciever solar thermal power system to be used in thermal enhanced oil recovery (TEOR) operations. Martin Marietta Corporation provides overall program management and also contributes heavily to the development of specifications, system selection, conceptual design (collector system sizing, layout and design), performance analysis and economic evaluations. Exxon as the potential system user provides the specific site, and has major input to system specifications, system selection, conceptual design, process analysis and economic evaluations. Foster Wheeler has responsibility for the analysis, design and cost estimating of the receiver. Black and Veatch is performing the analysis, design and costing of the field piping system, as well as evaluating tower and heliostat foundation requirements. The selected site (Exxon's Edison Field near Bakersfield, California) is briefly described, and the proposed solar steam generation system is discussed. (WHK)

30519 (SAND—80-8505, pp 97-105) **US Gypsum Plant Solar Retrofit Program.** Gintz, J.R. (Boeing Engineering and Construction Co., Seattle, WA). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

The site for the solar retrofit plant is on property owned by USG, east of Sweetwater, Texas, and about 40 miles west of Abilene. The USG property covers 3800 acres to carry out open-pit gypsum mining, gypsum rock-crushing, calcining, wallboard manufacturing and warehousing/shipping. All manufacturing operations are performed in a 16-acre area in the southwest portion of the site. The plant currently has two wallboard-drying kilns. A third board line is being added to be operational in 1981. Solar heat will be supplied to the furnace/kiln area of the new plant to displace natural gas usage. The collector field and tower will be located north of the plant beyond the tracks. Conceptual design of the system is described. (WHK)

30520 (SAND—80-8505, pp 106-110) **Gulf Mt. Taylor Uranium Mill solar retrofit.** Glover, L.W. (McDonnell Douglas Astronautics Co., Huntington Beach, CA). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

The Mt. Taylor Uranium Mill is designed to process 3.8×10^6 kilograms (4200 tons) or uranium ore yielding 11,340 kilograms per day (25,000 lbs/day) of equivalent U_3O_8 as finished yellowcake, when operating as planned for 24 hours/day. The processing steps include grinding, leaching, countercurrent decantation, solvent extraction, and yellowcake precipitation and drying; with steam injection at several points. This requires about 94,625 liters per day (25,000 gallons/day) peak of No. 2 petroleum fuel oil which is used to generate steam in two 6.3 kg/s (50,000 lbs/h) water tube boilers to maintain desired process temperatures. This study is exploring the use of a solar central receiver, in conjunction with the fossil fuel-fired boilers. Status is reviewed. (WHK)

30521 (SAND—80-8505, pp 111-119) **Solar retrofit of Provident Energy Company oil refinery.** Raghavan, R. (Foster Wheeler Development Corp., Livingston, NJ). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

The program objective is to prepare a conceptual design of a central receiver solar energy system for the PEC refinery that: (1) provides 20% or more of the steam requirements of the refinery; (2) achieves the best possible economics for the solar energy application, considering both capital and operating costs; (3) utilizes existing solar thermal technology; and (4) will be attractive to the refinery industry. The refinery, being designed by FWEC for the PEC, is to be built in Mobile, Arizona, which is 40 km (25 miles) southwest of Phoenix, Arizona. The refinery is scheduled for operation by 1983. The solar facility will be located adjacent to the northeastern edge of the refinery on a site that is ideal because the land is relatively flat and insolation is very high. The annual average daily value of direct normal insolation is 7.59 kWh/m^2.day (2400 Btu/h.ft^2). The system conceptual design is reviewed. (WHK)

30522 (SAND—80-8505, pp 120-129) **Solar industrial retrofit study.** Henry, R.L. (Northrup, Inc., Hutchins, TX). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

The objective of the program is to develop a site-specific conceptual design of a solar energy retrofit system that will be practical and cost effective in producing process heat for a typical petrochemical industrial application. Progress is reported. (WHK)

30523 (SAND—80-8505, pp 130-145) **Central Solar Receiver System for ammonia plant.** Rozenman, T. (PFR Engineering Systems, Inc., Marina Del Rey, CA). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

The conceptual design of a Solar Central Receiver System (SCRR) retrofit to a fossil fired reformer in an ammonia plant is presented. The baseline design consists of a solar reformer operating in parallel with the existing fossil fired reformer. The ammonia plant's process flow consisting of a mixture of natural gas and steam splits into two streams, one flowing to the solar receiver and the other to the existing fossil fired reformer. The process flow to the reformers undergoes identical chemical reaction in which hydrogen is formed. The two product streams merge and continue to flow according to the process flowsheet design. This baseline design does not require any storage or complex control. Maximum use is made of existing ammonia plant control techniques and operating practices. The SCRR furnishes approximately 82.0 GWth (280×10^9 Btu) which represents 22% of the fuel used in the fossil reformer.

30524 (SAND—80-8505, pp 316-323) **Heliostat cost/performance trade-offs for IPH.** Fish, M.J. (Sandia National Labs., Livermore, CA). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

As a function of heliostat reflectivity and size, heliostat breakeven costs in IPH applications are practically equivalent to electrical application results. This finding suggests that design considerations with respect to reflectivity and size are the same for either application. However, both tracking accuracy and surface quality indicate higher allowable costs for heliostats in lower temperature IPH applications compared to electrical generation. Aspects of the design affecting these performance parameters should therefore be the focal point for producing heliostats of greater potential cost effectiveness in low-temperature IPH applications.

30525 (SERI/TP—733-665) **Reducing fuel usage through applications of conservation and solar energy.** May, E.K.; Hooker, D.W. (Solar Energy Research Inst., Golden, CO (USA)). Apr 1980. Contract AC02-77CH00178. 13p. (CONF-800706—3). NTIS, PC A02/MF A01.

From Western plant engineering conference; Anaheim, CA, USA (15 Jul 1980).

Solar thermal technology, coupled with aggressive conservation measures, offers the prospect of greatly reducing the dependence of industry on oil and natural gas. The near-term market for solar technology is largely in industrial processes operating at temperatures below 288°C (550°F). Such process heat can be supplied by the relatively unsophisticated solar equipment available today. The number and diversity of industrial plants using process heat at this temperature allows favorable matches between solar technologies and industrial processes. The problems involved with the installation and maintenance of conservation and solar equipment are similar. Both compete for scarce investment capital, and each complicates industrial operations and increases maintenance requirements. Technological innovations requiring new types of equipment and reducing the temperature requirements of industrial processes favor the introduction of solar hardware. The industrial case studies program at the Solar Energy Research Institute has examined technical, economic, and other problems facing the near-term application of solar thermal technology to provide industrial process heat. The plant engineer is in the front line of any measure to reduce energy consumption or to supplement existing fuel supplies. The conditions most favorable to the integration of solar technology are presented and illustrated with examples from actual industrial plants.

WATER HEATING

REFER ALSO TO CITATION(S) 30476, 30514, 30515, 30516, 30517, 30539

30526 (DOE/NASA/CR—161481) **Solar energy system performance evaluation seasonal report for Elcam San Diego, San Diego, California.** (IBM Federal Systems Div., Huntsville, AL (USA)). May 1980. Contract AC01-77CS34049; AI01-76CS31037. 72p. NTIS, PC A04/MF A01.

The solar energy system, Elcam San Diego, was designed to supply domestic hot water heating for a single family residence located in Encinitas, California. The contents of this document have been divided into System Description, Performance Assessment, Operating Energy, Energy Savings, Maintenance and Summary and Conclusions. The system is a Sunspot two tank cascade type, where solar energy is supplied to either a 66 gallon preheat tank (solar storage) or a 40 gallon domestic hot water tank. Water is pumped directly from one of the two tanks, through the 65 square feet collector array and back into the same tank. Freeze protection is provided by automatically circulating hot water from the hot water tank through the collectors and exposed plumbing when freezing conditions exist. Auxiliary energy is supplied by natural gas. The Elcam San Diego solar energy system has three modes of operation.

SOLAR COLLECTORS AND CONCENTRATORS

REFER ALSO TO CITATION(S) 30429, 30448, 30449, 30450, 30451, 30452, 30453, 30455, 30458, 30524

30527 **Solar collector.** Wilhelm, W.G. US Patent Application 096,260. [nd]. 30p.

The invention pertains to a flat plate collector that employs high performance thin films. The solar collector of this invention overcomes several problems in this field, such as excessive hardware, cost and reliability, and other prior art drawbacks outlined in the specification. In the preferred form, the apparatus features a substantially rigid planar frame. A thin film window is bonded to one planar side of the frame. An absorber of laminate construction is comprised of two thin film layers that are sealed perimetrically. The layers define a fluid-tight planar envelope of large surface area to volume through which a heat transfer fluid flows. Absorber is bonded to the other planar side of the frame. The thin film construction of the absorber assures substantially full envelope wetting and thus good efficiency. The window and absorber films stress the frame adding to the overall strength of the collector.

30528 (CONF-780249—, pp 290-292) **Some experiences in marketing solar products.** Butt, S.H. (Olin Corp., East Aton, IL). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

Marketing experience of Olin Brass, the manufacturers of SOLAR-BOND integral tube-in-sheet absorber plates is related. The close association of Olin Brass as an original charter member of the Solar Energy Industries Association (SEIA) is discussed, and SEIA's close work with DOE and other federal agencies is mentioned. (WHK)

30529 (CONF-780249—, pp 293-306) **Solar collectors for cooling applications.** Collier, R.K. (Los Alamos Scientific Lab., NM). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

A description of collector research projects funded by the R & D Branch for Heating and Cooling, Department of Energy, which have direct applicability as cooling machine prime movers is given. Performance curves are given where they are available along with the development status and the market availability.

30530 (CONF-780249—, pp 361-364) **Standards for testing components of solar systems for thermal performance.** Newton, A.B. Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

The needs for standards to apply to the new components which make up solar systems are discussed. The standards presently available are reviewed, and additional standards under development are identified. The conclusion is reached that testing standards are now available for the two most important new components to solar heating and cooling systems, the collector and the storage. Standards are nearly ready for two specialized testing requirements, the collectors for swimming pool heating and the domestic water heaters. All these standards have been designed to allow designers to use their output to predict performance of systems in any locality under consideration.

30531 (CONF-780249—, pp 365-367) **S.E.R.E.F. solar collector rating, labeling and certification program.** Butt, S.H.; Brass, O. (Olin Corp., East Alton, IL). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

S.E.R.E.F has received a contract from the Department of Energy to develop a system for rating, labeling and certification of solar collectors. As a necessary prerequisite for rating thermal performance, S.E.R.E.F. is also to develop a procedure for accrediting test laboratories to perform thermal performance tests. The S.E.R.E.F. program involves both the development of a procedure for the rating of thermal performance and developing a means to test and validate collector reliability and durability. The product of the S.E.R.E.F contract will be a developed and ready to implement system to accomplish these purposes. As the system is developed, S.E.I.A. intends to implement it by establishing a voluntary rating, labeling and certification program for collectors. Progress is reported.

30532 (COO—4878-13) **Ceramic dome receiver technology developments.** Jarvinen, P.O. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 1980. Contract ET-78-S-02-4878. 6p. (CONF-800806—1). NTIS, PC A02/MF A01.

From 15. intersociety energy conversion engineering conference; Seattle, WA, USA (18 Aug 1980).

The development and experimental demonstration of a high-temperature seal for the SHARE ceramic dome cavity receiver is reported. The mechanical contact seal which was tested on one-foot-diameter silicon-carbide ceramic-dome hardware at pressure differentials to four atmospheres and dome temperatures to 2200°F (1200°C) showed negligible leakage at expected receiver operating conditions. Potential solar receiver applications for the technology are illustrated.

30533 (PNL—3286) **Evaluation of solar mirror figure by moire contouring.** Griffin, J.W.; Lind, M.A. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jun 1980. Contract AC06-76RL01830. 85p. NTIS, PC A05/MF A01.

Moire topography is applied to the figure assessment of solar mirrors. The technique is demonstrated on component facets of a six-meter diameter, four-meter focal length, parabolic dish collector. The relative ease of experimental implementation and subsequent data analysis suggests distinct advantages over the more established laser ray trace or BCS/ICS technique for many applications. The theoretical and experimental considerations necessary to fully implement moire topography on mirror surfaces are detailed. A procedure to de-specularize the mirror is demonstrated which conserves the surface morphology without damaging the reflective surface. The moire fringe patterns observed for the actual mirror facets are compared with theoretical contours generated for representative dish facets using a computer simulation algorithm. A method for evaluating the figure error of the real facet is presented in which the error parameter takes the form of an average absolute deviation of the surface slope from theoretical. The experimental measurement system used for this study employs a 200 line/inch Ronchi transmission grating. The mirror surface is illuminated by a collimated beam at 60°. The fringe observation is performed normal to the grating. These parameters yield contour intervals for the fringe patterns of 0.073 mm. The practical considerations for extending the techniques to higher resolution are discussed.

30534 (SAND—79-2190) **Solar mirror materials: their properties and uses in solar concentrating collectors.** Pettit, R.B.; Roth, E.P. (Sandia National Labs., Albuquerque, NM (USA)). Jun 1980. Contract AC04-76DP00789. 43p. NTIS, PC A03/MF A01.

The current state of mirror materials with application to solar concentrators is reviewed. After specular reflectance is defined, the optical measurement techniques developed specifically for these materials are discussed. Next, the solar reflectance properties of mirror materials, divided into categories of glass, metallize plastics, polished aluminum, and protective coatings, are summarized. Finally, current problem areas and future areas of research are discussed. (WHK)

30535 (SAND—79-2422) **Effect of soiling on solar mirrors and techniques used to maintain high reflectivity.** Roth, E.P.; Pettit, R.B. (Sandia National Labs., Albuquerque, NM (USA)). Jun 1980. Contract AC04-76DP00789. 52p. NTIS, PC A04/MF A01.

Solar mirrors are used to concentrate low-level solar radiation to power levels which are practical and efficient for consumption. Any interference with the collection of that energy not only decreases the power level but also increases the cost of the energy available from a solar power system. One of the most immediate and drastic effects of outdoor exposure is the reflectance loss due to the accumulation of foreign particles on the mirror surface. Specular reflectance losses as great as 25% have been observed for mirrors exposed for only a few weeks. The effect of the deposited particles is to reduce the reflected energy by both absorbing and scattering light. The degree to which the particles reduce the collection of reflected energy depends on their composition, number and size distribution. An additional factor is the optics of the collection system. The angular acceptance aperture of the system, defined as the angle subtended by the receiver at the concentrator surface, determines the relative importance of the scattering due to dust accumulation. For flat plate thermal and photovoltaic collectors which have essentially a 180° angular acceptance aperture, scattering of the incident light is not critical but absorption can be an important factor in the loss of energy. For concentrating collection systems, such as line focus collectors and central receivers, angular acceptance apertures of a few degrees make scattering at the concentrator surface much more important and can result in severe energy losses. Results of a study of each of these areas are presented and discussed. (WHK)

30536 (SAND—80-0702C) **Development of sheet molding compound solar collectors with molded-in silvered glass reflective surfaces.** Champion, R.L.; Allred, R.E. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 42p. (CONF-800686—1). NTIS, PC A03/MF A01.

From Society of Manufacturing Engineering Composites conference; Los Angeles, CA, USA (10 Jun 1980).

An approach to the fabrication of a line-focusng parabolic trough reflector structure which offers the potential of high performance while utilizing mass production type technology with potential for low cost is discussed. The concept is one of a molded structure of fiber reinforced plastic with an integrally molded silvered glass reflective surface. Sheet molding compound (SMC), a mixture of glass fibers and inorganic fillers in polyester resin, has been selected for evaluation as representative of reinforced plastic molding materials. The purpose of the work was to establish the feasibility of molding glass mirrors into SMC structural trough panels. If the effort proved successful, the next stage of development would be demonstration of the structure in a trough collector which incorporates individual SMC reflector panels. The trough has a 2 x 6 m aperture with six individual SMC panels mounted on a torque tube as the main support structure. Results are described. (WHK)

30537 (SAND—80-8505, pp 195-201) **Receiver program overview.** Wilson, W.G. (Sandia Labs., Livermore, CA). Jun 1980.

In Department of Energy large solar central power systems semiannual review.

Several major milestones in the Receiver Development Program were achieved in the last six months. Two major activities associated with the Barstow Pilot Plant, the CRTF single panel experiment and the 5-tube radiant heat experiment, have been completed. In addition, receiver experiments utilizing molten salt and liquid sodium are in the hardware preparation stage. A variety of additional receiver tests have been suggested for the CRTF and a series of analytical efforts dealing with convective losses, dynamic modeling, and radiation calculations have been initiated. Each of these topics are discussed briefly.

30538 (SERI/TP—632-645) **Line-focus sun trackers.** Gee, R. (Solar Energy Research Inst., Golden, CO (USA)). May 1980. Contract AC02-77CH00178. 6p. (CONF-800604—31). NTIS, PC A02/MF A01.

From American section of the International Solar Energy Society conference; Phoenix, AZ, USA (2 Jun 1980).

Sun trackers have been a troublesome component for line-focus concentrating collector systems. The problems have included poor accuracy, component failures, false locks on clouds, and restricted tracker operating ranges. In response to these tracking difficulties, a variety of improved sun trackers have been developed. A testing program is underway at SERI to determine the tracking accuracy of this new generation of sun trackers. The three major types of trackers are defined, some recent sun tracker developments are described, and the testing that is underway is outlined.

30539 (SERI/TP—733-759) **Solar ponds for district heating and electricity generation.** Leboeuf, C.; Kowalik, J.; Edesess, M.; Jayadev, T.S. (Solar Energy Research Inst., Golden, CO (USA)). Jul 1980. Contract AC02-77CH00178. 7p. (CONF-800806—31). NTIS, PC A02/MF A01.

From 15. intersociety energy conversion engineering conference; Seattle, WA, USA (18 Aug 1980).

System requirements, performance, and costs for the application of solar ponds to district heating and to electricity generation are considered. The optimal sizing and configuration of the solar ponds themselves are emphasized, but other system features are also investigated and discussed. Performance and costs range widely, depending upon location and component costs, particularly upon salt costs for the salt gradient pond. Distribution cost for district heating is also an important parameter that can vary widely. Both salt gradient and saltless ponds are considered.

30540 (TAC-STHC—78-001) **Solar thermal heating and cooling: a bibliography with abstracts. Quarterly update, January-March, 1978.** (New Mexico Univ., Albuquerque (USA). Technology Application Center). Jul 1977. 124p. Univ. of New Mexico, Albuquerque, NM.

Abstracts are presented in the following areas: material properties, flat plate collectors, concentrating collectors, thermal storage, heat pumps, coolers and heat exchangers, solar ponds and distillation, greenhouses, process heat, and irrigation pumps. An author index and a permuted title/keyword index are included. (MHR)

HEAT STORAGE

REFER ALSO TO CITATION(S) 30530, 30540, 30727

30541 (CONF-780249—, pp 310-312) **Thermal energy storage for cooling applications.** Fraley, S.K. (Oak Ridge National Lab., TN). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

The Low-Temperature Thermal Energy Storage (LTTES) Program at the Oak Ridge National Laboratory (ORNL) considers TES in the specific aspect of developing sensible and latent heat storage at temperatures up to approximately 250°C. This effort combines with similar programs at NASA-Lewis Research Center (sensible and latent heat storage at temperatures above about 250°C) and at Sandia Laboratories - Livermore (thermochemical energy storage and transport) to make up the TES technology development program of the Department of Energy'g Division of Energy Storage Systems (DOE-STOR). The LTTES program is described.

30542 (EUR—6739-EN) **Solar energy and low level cyclic energy flow (20 to 100°C) storage as chemical bond energy of compounds undergoing thermal decomposition. Final report.** Bougard, J.; Capron, P.; Jadot, R. (Faculte Polytechnique de Mons (Belgium). Centre de Recherches sur l'Energie Solaire). 1980. 238p. NTIS (US Sales Only), PC A11/MF A01.

Various materials and reactions are studied for thermochemical heat storage at low temperatures for application in solar annual energy storage. Thermochemical reactions with water vapor were studied including selected hydrates and some adsorbents and molecular sieves. Silica gels are studied in detail including physical properties and the basic principles of the reversible adsorption phenomenon. Thermochemical heat storage based on reactions with ammonia are considered, and the discontinuous heat pump is discussed. (WHK)

30543 (SERI/TR—631-647) **Preliminary screening of thermal storage concepts for water/steam and organic fluid solar thermal receiver systems.** Copeland, R.J.; Karpuk, M.E.; Ullman, J.L. (Solar Energy Research Inst., Golden, CO (USA)). Apr 1980. Contract EG-77-C-01-4042. 60p. NTIS, PC A04/MF A01.

A preliminary comparison of thermal storage concepts for solar thermal applications was done generically for large and small solar systems with sensible and latent heat and two-stage storage concepts. Concepts were ranked based on the cost of delivered energy. A +- 20% uncertainty in subsystem cost was included in the analysis. Water/steam and organic fluid collector/receivers were studied separately. For the water/steam concept, Barstow technology (100 MW/sub e/) was examined. A nitrite/nitrate salt with a low-cost solid medium was best for buffer storage; for diurnal storage, the two-stage draw salt/low-cost media and oil/rock con-

cept was best. Phase change concepts require improvements on the concept analyzed to be attractive. For the organic fluid system, a Shenandoah total energy system was examined. The Syltherm trickle charge taconite concept was the most favorable and may be improved by replacing the taconite with a lower-cost oil-compatible medium. Salt concepts can be competitive with this system only if there is a low-cost solid medium that is compatible with the salt and the end use requires a large amount of storage. The phase change concept examined was found to be quite poor for this total energy application.

GEOTHERMAL ENERGY

RESOURCE STATUS AND ASSESSMENT

USA

REFER ALSO TO CITATION(S) 30549

30544 (DOE/ID/12009—T1, pp 1-41) **Preliminary assessment of the geothermal potential of the Northern Hassayampa Plain, Maricopa County, Arizona.** Stone, C. Nov 1979.

In Geothermal studies in Arizona with two area assessments.

A preliminary assessment of the geothermal potential of the western half of the northern Hassayampa Plain has been made. A single shallow well with a measured temperature of 51°C initially called attention to the area. Field investigations were carried out between January and July, 1979. The field program consisted of (1) temperature logging of available water wells and mineral test holes, (2) collecting soil samples for mercury analysis, (3) taking water samples for major cation and anion analyses, and (4) conducting reconnaissance geologic mapping along the northeast side of the Belmont Mountains. Parts of this report are taken from published maps and reports and from unpublished field investigations conducted in 1972 to 1973.

30545 **Geothermal energy.** pp 397-421 of Energy in transition 1985-2010. Brooks, H.; Ginzton, E.L. (eds.). San Francisco, CA; W.H. Freeman and Co. (1980).

Sources of geothermal energy are not indefinitely sustainable in the same sense as solar energy. However, their total energy is so large that their potential as an energy source will depend mainly on their economic producibility, not on resource considerations. At present, the only usable geothermal resources are deposits of hot water or natural steam. In the long-term future, it may be possible to extract heat from the natural thermal gradient in the earth's crust and from unusually hot rock formations lying close to the earth's crust; the cost and the amount of energy that might be producible can be only grossly estimated. The only widespread potential geothermal resource, the natural thermal gradient, is the most speculative in practical exploitability. As an indefinitely sustainable source, it also suffers the inherent disadvantage that the normal heat flux from the inside of the earth is only about 1/1000 of the solar energy flux falling on the same area. One potentially large source of rather low temperature geothermal energy is the geopressured brines of the Gulf Coast. These brines may also hold very large amounts of dissolved natural gas. If the heat and gas can be exploited simultaneously, this might be an attractive resource. Considered in all of its potential, the geothermal resource represents extremely large amounts of energy. However, for a variety of technical, economic, geographical, and institutional reasons, geothermal energy will probably not be a major contributor to the national energy system until well into the twenty-first century, if ever. It may, however, become an important source of inexpensive heat for localized use at relatively small scales.

NON-USA

30546 **Geothermal energy exploitation in New Zealand.** Elder, J.W. Auckland, New Zealand; New Zealand Energy Research and Development Committee (1980). 27p. (NZERDC—52).

The essential factors, human and technical, which control the operation of geothermal systems, particularly those which allow prediction of behavior during and after exploitation, are sketched. The strategy and co-ordination involved in using New Zealand's geothermal resources for power production are considered. The broader aspects of the technical matters involved in the design of the parasitic plant reservoir system are described. (MHR)

GEOLOGY, HYDROLOGY, AND GEOTHERMAL SYSTEMS

30547 (LBL—9479) **Study of partial penetration in a two-layered aquifer. I. Analytical solution.** Javandel, I.; Witherspoon, P.A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1979. Contract W-7405-ENG-48. 29p. NTIS, PC A03/MF A01.

An analytic solution is presented to the problem of transient flow to a partially penetrating well that is open in either layer of finite thickness in a two-layered system. Crossflow is permitted at the interface between the two layers. Closed form solutions have been obtained which can easily be evaluated numerically. Simplified forms of the solutions for small and large values of time have been developed from the main solution. It has also been shown that the solution reduces to the case of single layer partial penetration once we allow the permeability of the nonperforated layer to vanish. The approach here is to start with the problem when the pumping well is open only in the top layer. A second solution is also developed when the well is partially penetrating only in the lower layer.

30548 (LBL—10861) **SHAFT79 user's manual.** Pruess, K.; Schroeder, R.C. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1980. Contract W-7405-ENG-48. 53p. NTIS, PC A04/MF A01.

SHAFT79 (Simultaneous Heat And Fluid Transport) is an integrated finite difference program for computing two-phase nonisothermal flow in porous media. The principal application for which SHAFT79 is designed is in geothermal reservoir simulation. SHAFT79 solves the same equations as an earlier version, called SHAFT78, but uses much more efficient mathematical and numerical methods. The present SHAFT79 user's manual gives a brief account of equations and numerical methods and then describes in detail how to set up input decks for running the program. The application of SHAFT79 is illustrated by means of a few sample problems. (MHR)

USA

REFER ALSO TO CITATION(S) 30544, 30554, 30555

30549 (DOE/ID/12009—T1) **Geothermal studies in Arizona with two area assessments. Progress report, 16 January-1 November 1979.** Hahman, W.R. Sr. (Arizona Univ., Tucson (USA). Bureau of Geology and Mineral Technology). Nov 1979. Contract FC07-79ID12009. 189p. NTIS, PC A09/MF A01.

Five papers are included. Separate abstracts were prepared for each one. (MHR)

30550 (DOE/ID/12009—T1, pp 68-114) **Preliminary geothermal assessment of the Willcox basin.** Jones, N.O. Nov 1979.

In Geothermal studies in Arizona with two area assessments.

A review of existing data concerning the Willcox Basin was undertaken as a first step in assessing the area's geothermal potential. This, coupled with additional information gathered from firsthand field examinations and explicit water chemistry suggest three areas where temperatures from 40 to 100°C may be found at depths of 500 to 1000 meters. Projection of thermal gradients within the basin suggest energy-producing temperatures at depths of about 3000 meters. (MHR)

30551 (DOE/ID/12009—T1, pp 115-155) **Preliminary geothermal assessment of the Hyder area.** Jones, N.O.; Campbell, A. Nov 1979.

In Geothermal studies in Arizona with two area assessments.

A review of existing geological, hydrological and temperature data from the Dateland-Hyder area was undertaken. Additional information was gathered from firsthand field observations and discussions with the local population. Temperature measurements and chemical geothermometry suggest three areas where 40 to 100°C waters may be found at depths of 500 to 1000 meters. Projection of thermal gradients indicate 200°C temperatures may be encountered at depths as shallow as 2000 meters. (MHR)

30552 (DOE/ID/12009—T1, pp 156-173) **Geothermal reconnaissance study of the San Francisco River between Clifton, Arizona and Pleasanton, New Mexico.** Witcher, J.C. Nov 1979.

In Geothermal studies in Arizona with two area assessments.

Geologic reconnaissance of the San Francisco River between Clifton, Arizona, and Pleasanton, New Mexico, shows the area to have high potential for the occurrence of high to moderate temperature (> 120°C) geothermal reservoirs, which could be utilized for electrical power production, for direct use, and desalination to augment existing water supplies. Areas surrounding the Clifton Hot Springs and the lower San Francisco Hot Springs are designated as federal KGRA's (known geothermal resource areas). The Martinez Ranch area along the San Francisco River has geothermal resource possibilities similar to those observed at Clifton and at the lower San Francisco Hot Springs. High to moderate temperature (> 120°C)

geothermal resources are indicated in all of these areas by this and earlier studies. (MHR)

GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY

REFER ALSO TO CITATION(S) 30544, 30549, 30550, 30551, 30552

30553 (DOE/ID/12009—T1, pp 42-67) **Geothermal energy in Arizona.** Hahman, W.R. Sr. Nov 1979.

In Geothermal studies in Arizona with two area assessments. The Bureau of Geology and Mineral Technology, Geological Survey Branch, has been exploring for geothermal energy since May 1977. The known major geothermal systems in Arizona are apparently caused by deep circulation of meteoric water through the complex fracture systems of the Basin and Range region and transition zone. This type of system is thought to be capable of generating geothermal reservoirs with temperatures on the order of 150 to 200°C at 2-3 km depth in the intermontane basin. Some of the results of the exploration and evaluation program for geothermal energy in Arizona are presented.

30554 (LA-UR—80-1688) **Low enthalpy convective system in Western Ohio.** Cannon, M.S.; Tabet, C.A.; Eckstein, Y. (Los Alamos Scientific Lab., NM (USA); Kent State Univ., OH (USA)). 1980. Contract W-7405-ENG-36. 5p. (CONF-800920—19). NTIS, PC A02/MF A01.

From Geothermal Resource Council annual meeting; Salt Lake City, UT, USA (9 Sep 1980).

A distinct positive anomaly in the temperatures of the shallow (Pleistocene) aquifers along the Cincinnati-Findlay Arch in Western Ohio coincides with a low geothermal gradient. A conceptual model of convective currents associated with a tensional fault and/or fracture system along the crest of the Arch is suggested as an explanation of the anomaly. Hydrochemical information indicates that various quantities of warmer ground water, with the composition characteristics of deep bedrock aquifers, is present as an admixture in the shallow aquifers. This confirms the conceptual model of convection in fractures.

GEOPHYSICAL TECHNIQUES AND SURVEYS

30555 (LA-UR—80-1488) **Preliminary geological and geophysical evaluation of the Castle Dome HDR geothermal prospect, Southwestern Arizona.** Gutmann, J.T.; Aiken, C.L.V.; Ander, M.E.; Laney, R.T. (Wesleyan Univ., Middletown, CT (USA); Texas Univ., Richardson (USA); Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 4p. (CONF-800920—3). NTIS, PC A02/MF A01.

From Geothermal Resource Council annual meeting; Salt Lake City, UT, USA (9 Sep 1980).

The Castle Dome HDR geothermal prospect is located in Yuma County, Arizona, in a region centered about 80 km north of Yuma along US Rte. 95. The area of interest is broadly defined by a negative residual Bouguer gravity anomaly which is about 45 km across, steep-sided in many places, and as much as 30 mgals in magnitude. The geology of this Basin and Range area is poorly known, but the few published reports and current Los Alamos Scientific Laboratory (LASL) field studies indicate that the Castle Dome Mountains and adjacent ranges are chiefly a thick pile of welded ash-flow tuffs of probable mid-Tertiary age. The tuffs rest unconformably on Mesozoic metasedimentary rocks exposed only outside steep edges of the gravity low. This gravity anomaly may reflect the presence of a large caldera. A regional magnetotelluric study now in progress will define the depths to electrical conductors within the crust and upper mantle and contribute to understanding of crustal structure, the gravity anomaly, and the Hot Dry Rock (HDR) geothermal potential of the Castle Dome area.

30556 (LA-UR—80-1489) **Geothermal gradient map of the United States.** Kron, A.; Heiken, G. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 4p. (CONF-800920—2). NTIS, PC A02/MF A01.

From Geothermal Resource Council annual meeting; Salt Lake City, UT, USA (9 Sep 1980).

A geothermal gradient map is needed in order to determine the hot dry rock (HDR) geothermal resource of the United States. Based on published and unpublished data (including new measurements) the HDR program will produce updated gradient maps annually, to be used as a tool for resource evaluation and exploration. The 1980 version of this map is presented.

30557 (LA-UR—80-1639) **Eastern hot dry rock target prospect: a case history.** Schubert, C.E.; Maxwell, J.C.; Johnson, W.J. (D'Appolonia Consulting Engineers, Inc., Pittsburgh, PA (USA); Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 5p. (CONF-800920—21). NTIS, PC A02/MF A01.

From Geothermal Resource Council annual meeting; Salt Lake City, UT, USA (9 Sep 1980).

The Eastern Hot Dry Rock Target Prospect is located in a corridor between Smith Island, Maryland on Chesapeake Bay and the southern tip of Assateague Island, Virginia on the Atlantic Ocean. The prospect was selected for investigation based on anomalously high heat flow values and thermal gradients previously determined. The exploration program was aimed at locating the most favorable location within the site area for the targeting of a deep test borehole for HDR heat extraction. The program consisted of an aeromagnetic survey, gravity/magnetic analysis, time-domain electromagnetic (TDEM) survey, Vibroseis seismic reflection profiling, drilling and logging of four 300-meter borings, and the reopening and logging of an abandoned oil exploration hole. The preliminary results of this nearly completed study indicate that the area has potential for the extraction of heat using the Hot Dry Rock concept.

30558 (LBL—10987) **Comparison of dipole-dipole resistivity and electromagnetic induction sounding over the Panther Canyon thermal anomaly, Grass Valley, Nevada.** Wilt, M.; Beyer, J.H.; Goldstein, N.E. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.; Woodward-Clyde Consultants, San Francisco, CA (USA)). May 1980. Contract W-7405-ENG-48. 5p. (CONF-800920—7). NTIS, PC A02/MF A01.

From Geothermal Resource Council annual meeting; Salt Lake City, UT, USA (9 Sep 1980).

A comparison is made between the dipole-dipole resistivity method and electromagnetic sounding method based on surveys over a geothermal anomaly near Panther Canyon, Grass Valley, Nevada. Dipole-dipole data were taken in conjunction with large-scale geothermal studies in the area. Two orthogonal lines were measured over the heat flow anomaly and two-dimensional modeling was performed on the data. EM sounding data were taken with the Lawrence Berkeley Laboratory EM-60 system which is a large-moment, frequency-domain, horizontal-loop system. Relative to single 50-meter-radius transmitter coil, eight soundings were made with detectors at distances of 0.5 to 1.6 km from the loop. Interpreted results from the two surveys indicate substantial agreement in the depth to and thickness of a conductive zone that may be associated with the thermal anomaly. The dipole-dipole method is inherently better for resolving resistive basement beneath the conductive anomaly, and dc resistivity interpretation techniques are presently better to handle the complex two-dimensional geology. However, the EM method is far less labor intensive, requiring only one-third the field time for similar areal coverage.

EXPLORATORY DRILLING AND WELL LOGGING

REFER ALSO TO CITATION(S) 30547

30559 **Induction logging device.** Koelle, A.R.; Landt, J.A. (to Dept. of Energy). US Patent Application 067,856. [nd]. 21p.

An instrument is disclosed for mapping vertical conductive fractures in a resistive bedrock, magnetically inducing eddy currents by a pair of vertically oriented, mutually perpendicular, coplanar coils. The eddy currents drive magnetic fields which are picked up by a second, similar pair of coils.

30560 **Caliper and contour tool.** Fink, C.F. US Patent Application 061,149. [nd]. 9p.

The disclosure relates to a tool for borehole logging comprising a plurality of extendable caliper arms to determine borehole contour.

30561 (DOE/EV/05268—T1) **Feasibility investigation and design study of optical well logging methods for high temperature geothermal wells.** Swanson, R.K.; Anderson, R.E.; Ash, J.I.; Beissner, R.E.; Smith, V.D. (Southwest Research Inst., San Antonio, TX (USA)). Mar 1978. Contract AC05-76EV05268. 131p. NTIS, PC A07/MF A01.

The objective of this project was exploration of a novel approach to high temperature well logging, based on a system of optical transducers and an optical transmission line both theoretically capable of operation to at least 600°C. The scope of the work involved the accomplishment of ten specific tasks. These had as their objective the determination of feasibility, and identification of major problem areas, in the implementation of continuous temperature logging of geothermal wells using optical techniques. The following tasks are reported: literature review and data compilation, measurement of fiber properties production fiber procurement, investigation of methods of fiber termination, cable design and fabrication, and sensor and system studies. (MHR)

30562 (SAND—80-0705C) **Pressure measurements in low permeability formations.** Veneruso, A.F.; McConnell, T.D. (Sandia Na-

tional Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 19p. (CONF-800344—2). NTIS, PC A02/MF A01.

From 3. invitational well testing symposium; Oakland, CA, USA (26 Mar 1980).

This paper examines the performance requirements and identifies candidate hardware implementations for pressure instrumentation that is needed to provide well test data in low permeability formations. Low permeability values are typically defined to be less than 1 microdarcy and are usually encountered in hard rock formations, such as granite, that are of interest in hot dry rock geothermal, deep exploration drilling, and fluid waste disposal. Groundwater flow in these tight formations has been shown to be dominated by flow-through fractures rather than through the formation's intrinsic permeability. In these cases, we cannot use Darcy's law or the usual dimensionless coefficients to estimate the expected scale factors and dynamic responses necessary to properly select and setup the wellbore pressure instrument. This paper shows that the expected instrument responses can be estimated using some recent work by Wang, Narasimhan, and Witherspoon. This paper further describes the minimum electronic capability that the downhole pressure instrument must have in order to provide the required measurement resolution, dynamic range, and transient response. Three specific hardware implementations are presented based on the following transducers: a quartz resonator, a capacitance gauge, and a resistance strain gauge.

30563 (SAND—80-1282C) **Pressure instrumentation for geothermal borehole logging.** McConnell, T.D. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 4p. (CONF-800920—10). NTIS, PC A02/MF A01.

From Geothermal Resource Council annual meeting; Salt Lake City, UT, USA (9 Sep 1980).

Accurate geothermal logging requires pressure measurements with resolutions down to 0.01 psi in environments of up to 275°C and 15,000 psi. The characteristics of several basic types of pressure transducers are examined and compared to these requirements. Specific deficiencies are identified such as thermal stability and resolution limitations; R & D activities and results correcting these deficiencies are discussed.

LEGAL AND INSTITUTIONAL ASPECTS

REFER ALSO TO CITATION(S) 30545

ECONOMIC AND FINANCIAL ASPECTS

30564 (DOE/RL/01049—T7) **Geothermal energy in Idaho: site data base and development status.** McClain, D.W. (Oregon Inst. of Tech., Klamath Falls (USA). Geo-Heat Utilization Center). Jul 1979. Contract AC06-77RL01049. 449p. NTIS, PC A19/MF A01.

Detailed site specific data regarding the commercialization potential of the proven, potential, and inferred geothermal resource areas in Idaho are presented. To assess the potential for geothermal resource development in Idaho, several kinds of data were obtained. These include information regarding institutional procedures for geothermal development, logistical procedures for utilization, energy needs and forecasted demands, and resource data. Area reports, data sheets, and scenarios were prepared that described possible geothermal development at individual sites. In preparing development projections, the objective was to base them on actual market potential, forecasted growth, and known or inferred resource conditions. To the extent possible, power-on-line dates and energy utilization estimates are realistic projections of the first events. Commercialization projections were based on the assumption that an aggressive development program will prove sufficient known and inferred resources to accomplish the projected event. This report is an estimate of probable energy developable under an aggressive exploration program and is considered extremely conservative. (MHR)

ENVIRONMENTAL ASPECTS AND WASTE DISPOSAL

REFER ALSO TO CITATION(S) 30576, 31113

30565 (CONF-800567—3) **Behavior of temperature and concentration of shallow groundwater in the Raft River Geothermal Area.** Tang, D.H.; Goldman, D.; Martinez, J.A.; Lantz, R.B. (INTERA Environmental Consultants, Inc., Houston, TX (USA); Idaho National Engineering Lab., Idaho Falls (USA)). 1980. Contract AC07-76ID01570. 6p. NTIS, PC A02/MF A01.

From International symposia alternative energy sources and technology; Montreal, Canada (28 May 1980).

A moderate-temperature (140°C) geothermal power plant demonstration, sponsored by the Department of Energy, is currently under development in South Central Idaho. Environmental concerns about the quality of the local shallow groundwater prompted a modeling study. Simulation results (1) suggest significant thermal and quality levels within the 30-year projected plant operation and (2) makes obvious the importance of understanding the interconnected hydraulic systems.

30566 (CONF-800920—17) **Numerical simulation of the impact of fluid injection in the Raft River geothermal area.** Spencer, S.G.; Goldman, D. (EG and G Idaho, Inc., Idaho Falls (USA)). 1980. Contract AC07-76ID01570. 8p. NTIS, PC A02/MF A01.

From Geothermal Resource Council annual meeting; Salt Lake City, UT, USA (9 Sep 1980).

A moderate-temperature geothermal pilot power plant, sponsored by the Department of Energy, is currently under development in southcentral Idaho. Environmental concerns regarding the impact of intermediate-depth injection on shallower aquifers prompted a computer simulation study. Results of the modeling suggest: (1) significant thermal and water quality in shallow aquifers within the 30-year design life of the plant, and (2) the importance of understanding the interconnected hydraulic systems. The results may be artificial, reflecting the spatially limited data.

30567 (DOE/EV—0083) **State-of-the-art of liquid waste disposal for geothermal energy systems: 1979. Report PNL-2404.** Defferding, L.J. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jun 1980. Contract AC06-76EV01831. 252p. NTIS, PC A12/MF A01.

The state-of-the-art of geothermal liquid waste disposal is reviewed and surface and subsurface disposal methods are evaluated with respect to technical, economic, legal, and environmental factors. Three disposal techniques are currently in use at numerous geothermal sites around the world: direct discharge into surface waters; deep-well injection; and ponding for evaporation. The review shows that effluents are directly discharged into surface waters at Wairakei, New Zealand; Larderello, Italy; and Ahuachapan, El Salvador. Ponding for evaporation is employed at Cerro Prieto, Mexico. Deep-well injection is being practiced at Larderello; Ahuachapan; Otake and Hatchobaru, Japan; and at The Geysers in California. All sites except Ahuachapan (which is injecting only 30% of total plant flow) have reported difficulties with their systems. Disposal techniques used in related industries are also reviewed. The oil industry's efforts at disposal of large quantities of liquid effluents have been quite successful as long as the effluents have been treated prior to injection. This study has determined that seven liquid disposal methods - four surface and three subsurface - are viable options for use in the geothermal energy industry. However, additional research and development is needed to reduce the uncertainties and to minimize the adverse environmental impacts of disposal. (MHR)

30568 (LBL—10837) **Detailed report on tested models companion report 2 to simulation of geothermal subsidence (LBL 10571).** Miller, I.; Dershowitz, W.; Jones, K.; Myer, L.; Roman, K.; Schauer, M. (Golder Associates, Inc., Seattle, WA (USA)). Mar 1980. Contract W-7405-ENG-48. 206p. NTIS, PC A10/MF A01.

An assessment was performed of existing mathematical models for subsidence simulation and prediction. Detailed analyses are presented of the theory, power, usability, and performance of the seven models used in conjunction with an ongoing research program aimed at improved understanding and control of ground movements caused by geothermal power production. The models used were: hand-calculation techniques; the nucleus-of-strain method; the one-dimensional Terzaghi consolidation method; the two-dimensional boundary-integral-equation method; two-dimensional finite-element coupled fluid flow and deformation; three-dimensional integrated finite difference, coupled fluid flow, heat flow, and porosity change; and the three-dimensional displacement discontinuity method. (MHR)

30569 (LBL—10983) **Injection into a fractured geothermal reservoir.** Bodvarsson, G.S.; Tsang, C.F. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1980. Contract W-7405-ENG-48. 5p. (CONF-800920—23). NTIS, PC A02/MF A01.

From Geothermal Resource Council annual meeting; Salt Lake City, UT, USA (9 Sep 1980).

A detailed study is made on the movement of the thermal fronts in the fracture and in the porous medium when 100°C water is injected into a 300°C geothermal reservoir with equally spaced horizontal fractures. Numerical modeling calculations were made for a number of thermal conductivity values, as well as different values of the ratio of fracture and rock medium permeabilities. One important result is an indication that although initially, the thermal front in the fracture moves very fast relative to the front in the porous medium as commonly expected, its speed rapidly decreases. At some distance from the injection well the thermal fronts in the fracture and the porous medium coincide, and from that point they advance

together. The implication of this result on the effects of fractures on reinjection into geothermal reservoirs is discussed.

30570 (UCRL—84459) **Methane extraction from geopressured-geothermal brine at wellhead conditions.** Quong, R.; Owen, L.B.; Locke, F.E.; Otto, C.H.; Netherton, R.; Lorensen, L.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 29 May 1980. Contract W-7405-ENG-48. 5p. (CONF-800920—6). NTIS, PC A02/MF A01.

From Geothermal Resource Council annual meeting; Salt Lake City, UT, USA (9 Sep 1980).

Disposal of geopressured-geothermal brine effluents by injection is expected to be costly, even into shallow aquifers. If injection into the production reservoir becomes necessary to maintain productivity and to minimize subsidence, the injection pumping costs can become overwhelming. An option aimed at reducing injection pump operating costs is to maintain a higher than normal pressure at the production wellhead to reduce the injection pumping load. The crucial element, however, is that a significant portion of CH_4 remains in solution and must be recovered in order for the pressure maintenance option to be cost effective. A laboratory and field test capability has been established, and several methods for extracting dissolved CH_4 at high temperature and pressure are being evaluated. Solvent extraction and use of hydraulic motors or turbines coupled to CH_4 recovery systems are the leading candidate methods.

30571 **Process for purifying geothermal steam.** Li, C.T. (to Dept. of Energy). US Patent 4,196,183. 1 Apr 1980. Filed date 24 Jan 1979. 6p.

PAT-APPL-5,942.

Steam containing hydrogen sulfide is purified and sulfur recovered by passing the steam through a reactor packed with activated carbon in the presence of a stoichiometric amount of oxygen which oxidizes the hydrogen sulfide to elemental sulfur which is adsorbed on the bed. The carbon can be recycled after the sulfur has been recovered by vacuum distillation, inert gas entrainment of solvent extraction. The process is suitable for the purification of steam from geothermal sources which may also contain other non-condensable gases.

BY-PRODUCTS

REFER ALSO TO CITATION(S) 30570

GEOTHERMAL POWER PLANTS

POWER PLANT SYSTEMS AND COMPONENTS

30572 **Velocity pump reaction turbine.** House, P.A. US Patent Application 098,450. [nd]. 26p.

An expanding hydraulic/two-phase velocity pump reaction turbine including a dual concentric rotor configuration with an inter-rotor annular flow channel in which the inner rotor is mechanically driven by the outer rotor. In another embodiment, the inner rotor is immobilized and provided with gas recovery ports on its outer surface by means of which gas in solution may be recovered. This velocity pump reaction turbine configuration is capable of potential energy conversion efficiencies of up to 70%, and is particularly suited for geothermal applications.

30573 (CONF-800723—21) **Enhanced condenssation heat transfer.** Michel, J.W.; Murphy, R.W. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 20p. NTIS, PC A02/MF A01.

From 19. national heat transfer conference; Orlando, FL, USA (27 Jul 1980).

For the past four years, work has been in progress at ORNL to develop improved condensers for geothermal binary power cycles. The work has centered on optimizing the design variables associated with fluted surfaces on vertical tubes and comparing the tube performance with available enhanced tubes either for vertical or horizontal operation. Data with seven fluids including a hydrocarbon, fluorocarbons, and ammonia condensing on up to 30 different tubes have been obtained. Data for tubes of different effective lengths (1/2 to 4 ft) and inclination have also been obtained. The primary conclusion from this work is that the best fluted tubes can provide an enhancement in condensation coefficient by a factor of approximately 6 over smooth vertical tube performance and a factor of approximately 2 over the best enhanced commercial tubes either operating vertically or horizontally. These data, together with field test data have formed the basis for designing two prototype condensers, one for the 60 kWe Raft River, Idaho, pilot plant and one for the 500 kWe East Mesa, California, direct-contact demonstration plant.

GEOTHERMAL ENGINEERING

DRILLING TECHNOLOGY AND WELL HARDWARE

30574 (LA-UR—80-1485) **Monitoring and repairing geothermal casing cement: a case history.** Pettitt, R.A. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 5p. (CONF-800920—5). NTIS, PC A02/MF A01.

From Geothermal Resource Council annual meeting; Salt Lake City, UT, USA (9 Sep 1980).

A manmade geothermal reservoir has been created by drilling a deep hole into relatively impermeable hot rocks, creating a large surface area for heat transfer by hydraulic fracturing, then drilling a second hole to intersect the fracture to complete the closed circulation loop. A second generation system, presently being drilled, will entail creating multiple, parallel, vertical fractures between a pair of inclined boreholes. The original completion of injection Hole EE-1, consisting of a conventional high-temperature formulation of Class B portland cement, stabilized with 40% silica sand, did not withstand the cyclic stresses, and rapid deterioration of casing-to-cement and cement-to-formation bonds occurred, which allowed significant flow in the resulting microannulus. The performance history of the casing cement for the existing HDR EE-1 injection well, the subsequent remedial cementing program, the cement bond logs, and the radioactive isotope tracer injections tests, used to monitor the condition of the casing cement is described. (MHR)

30575 (LA-UR—80-1487) **Evolution of a Hybrid Roller Cone/PDC core bit.** Pettitt, R.; Laney, R.; George, D.; Clemens, G. (Los Alamos Scientific Lab., NM (USA); Smith (Sii) Tool, Irvine, CA (USA); NL Hycalog/NL Industries, Inc., Houston, TX (USA)). 1980. Contract W-7405-ENG-36. 5p. (CONF-800920—4). NTIS, PC A02/MF A01.

From Geothermal Resource Council annual meeting; Salt Lake City, UT, USA (9 Sep 1980).

The development of the hot dry rock (HDR) geothermal resource, as presently being accomplished by the Los Alamos Scientific Laboratory (LASL), requires that sufficient quantities of good quality core be obtained at a reasonable cost. The use of roller cone core bits, with tungsten carbide inserts, was initiated by the Deep Sea Drilling Program. These bits were modified for continental drilling in deep, hot, granitic rock for the LASL HDR Geothermal Site at Fenton Hill, New Mexico in 1974. After the advent of monocrystalline diamond Stratapax pads, a prototype hybrid roller cone/Stratapax core bit was fabricated by Smith Tool, and tested at Fenton Hill in 1978. During the drilling for a deeper HDR reservoir system in 1979 and 1980, six of the latest generation of these bits, now called Hybrid Roller Cone/Polycrystalline Diamond Cutter (PDC) core bits, were successfully used in granitic rock at depths below 11,000 ft.

GEOTHERMAL RESERVOIR AND WELL PERFORMANCE

REFER ALSO TO CITATION(S) 30548

30576 (LBL—10985) **Analysis of injection testing of geothermal reservoirs.** O'Sullivan, M.; Pruess, K. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1980. Contract W-7405-ENG-48. 5p. (CONF-800920—22). NTIS, PC A02/MF A01.

From Geothermal Resource Council annual meeting; Salt Lake City, UT, USA (9 Sep 1980).

By introducing a similarity variable $r/\sqrt{t}$ a quasi-analytical method can be used to calculate the flow induced by the injection of cold water into a hot water or boiling geothermal reservoir. The results obtained are compared with those produced by the reservoir simulator SHAFT79 and show good agreement.

RESERVOIR STIMULATION AND EXTRACTION TECHNOLOGY

30577 (CONF-800920—16) **Results of acid treatments in hydrothermal direct heat experiment wells.** Strawn, J.A. (EG and G Idaho, Inc., Idaho Falls (USA)). 1980. Contract AC07-76ID01570. 7p. NTIS, PC A02/MF A01.

From Geothermal Resource Council annual meeting; Salt Lake City, UT, USA (9 Sep 1980).

Matrix acid treatments have been employed in two low-to-moderate temperature hydrothermal wells with successful results. These two wells showed flow rate increases of 40% and 50%. The increased flow reduced the payback periods for the heating systems to nearly one-half of what they were before acidization. It is recommended that well designs in certain areas consider accommodating such acid stimulation techniques, if testing suggests they are warranted as a well completion tool.

30578 (LA-UR—80-1825) **Geothermal well stimulation.** Sinclair, A.R.; Pittard, F.J.; Hanold, R.J. (Maurer Engineering, Inc., Houston, TX (USA); Los Alamos Scientific Lab., NM (USA)). 1980.

Contract W-7405-ENG-36. 5p. (CONF-800920—18). NTIS, PC A02/MF A01.

From Geothermal Resource Council annual meeting; Salt Lake City, UT, USA (9 Sep 1980).

All available data on proppants and fluids were examined to determine areas in technology that need development for 300 to 500°F (150° to 265°C) hydrothermal wells. While fluid properties have been examined well into the 450°F range, proppants have not been previously tested at elevated temperatures except in a few instances. The latest test data at geothermal temperatures is presented and some possible proppants and fluid systems that can be used are shown. Also discussed are alternative stimulation techniques for geothermal wells.

DIRECT ENERGY UTILIZATION

30579 (CONF-800920—15) **Progress in direct heat applications projects.** Childs, F.W.; Jones, K.W.; Nelson, L.B.; Strawn, J.A.; Tucker, M.K. (EG and G Idaho, Inc., Idaho Falls (USA)). 1980. Contract AC07-76ID01570. 9p. NTIS, PC A02/MF A01.

From Geothermal Resource Council annual meeting; Salt Lake City, UT, USA (9 Sep 1980).

The development of hydrothermal energy for direct heat applications is being aided by twenty-two demonstration projects that are funded on a cost-sharing basis by the US Department of Energy, Division of Geothermal Energy. These projects are designed to demonstrate the technical and economic feasibility of the direct use of geothermal heat in the United States. Twelve of these projects are administered by the DOE-Idaho Operations Office with technical support from EG & G Idaho, Inc. Engineering and economic data for these projects are summarized in this paper. The data and experience being generated by these projects will be an important basis for future geothermal direct use projects.

WIND ENERGY

30580 (NYSERDA—79-5) **Barriers to the application of wind energy conversion systems in urban settings.** Kroner, W.M. (ed.). (Rensselaer Polytechnic Inst., Troy, NY (USA)). Dec 1979. 174p. New York State Energy Research and Development Authority, Albany, NY.

Urban areas in the Northeast region of the United States, and specifically, those in New York State are unique in many respects and tend not to match urban characteristics in other areas of the country. The installation of WECS in these urban areas could create technical, community, economic, industrial, legal and ownership related problems which, in turn, could constitute a series of barriers preventing or discouraging the implementation or use of WECS. A study of these barriers is presented.

30581 (SERI/TP—732-343) **Proceedings: panel on information dissemination for wind energy.** Weis, P. (ed.). (Solar Energy Research Inst., Golden, CO (USA)). Apr 1980. Contract AC02-77CH00178. 86p. NTIS, PC A05/MF A01.

This meeting was called as part of a multi-year planning effort. Groups involved in the production and/or dissemination of information on wind energy were invited to describe their current activities and their perceptions of the needs of the 80's in this area. Participants exchanged copies of materials they distribute regularly and discussed frequently asked questions.

30582 **Energy from the wind: annotated bibliography.** Burke, B.L. (comp.). Fort Collins, CO; Colorado State University (1979). 437p. (NP—24383).

This Second Supplement to Energy From the Wind, which contains 1942 new references, was produced by computer, as the first phase of a project which will eventually put the retrospective file (Basic Volume and First Supplement) as well as all future supplements on computer. The bibliography is organized by year, in entry number order. So that the Second Supplement may be merged with the Basic Volume and First Supplement if desired, entry numbers in the Second Supplement are assigned to follow consecutively those entry numbers used in the first two volumes. The Second Supplement may be merged with the first two volumes, or left separate. The indexes in the Second Supplement are for that supplement only, so if the three volumes are merged, the old indexes must be retained and used with the indexes for the Second Supplement.

AVAILABILITY (CLIMATOLOGY)

REFER ALSO TO CITATION(S) 30594

REGULATIONS

30583 (SERI-TP—744-466R) **Product liability insurance for WECS.** Noun, R.J. (Solar Energy Research Inst., Golden, CO (USA)). Jun 1980. Contract AC02-77CH00178. 7p. (CONF-800604—30). NTIS, PC A02/MF A01.

From American section of the International Solar Energy Society conference; Phoenix, AZ, USA (2 Jun 1980).

Preliminary findings from a sampling of manufacturers indicate that, in many cases, product liability insurance for WECS is still difficult to obtain. About half of the 21 WECS manufacturers contacted said they did not have product liability insurance. About one manufacturer in three who attempted to obtain insurance was rejected by at least one insurance company. In some instances, although an insurer had offered to provide coverage, the manufacturer found the rates quoted to be prohibitively expensive. For example, in one case a WECS manufacturer had been offered product liability insurance, but at an annual rate of 30% of his gross sales.

ECONOMICS

REFER ALSO TO CITATION(S) 30589, 30590, 30591

30584 (ANL/AA—17) **Reliability, energy, and cost effects of wind-powered generation integrated with a conventional generating system.** VanKuiken, J.C.; Buehring, W.A.; Huber, C.C.; Hub, K.A. (Argonne National Lab., IL (USA)). Jan 1980. Contract W-31-109-ENG-38. 114p. NTIS, PC A06/MF A01.

The purpose of this investigation is to examine the potential impacts of incorporating wind turbines, without the aid of energy-storage devices, into a conventional electrical generating system. This study focuses on the contribution to generating-system reliability of wind turbines, and the methods used to calculate these benefits. In addition, a simple cost model was developed to estimate ranges of breakeven costs for wind turbines based on the sum of fuel cost savings, variable operation and maintenance (0 and M) cost savings, and reliability benefits of the wind turbines.

ENVIRONMENTAL ASPECTS

30585 (DOE/EV—0089) **Preliminary analysis of the audible noise of constant-speed, horizontal-axis wind-turbine generators.** Keast, D.N.; Potter, R.C. (Bolt, Beranek, and Newman, Inc., Cambridge, MA (USA)). Jul 1980. Contract AP01-79EV10014. 72p. NTIS, PC A04/MF A01.

An analytical procedure has been developed for calculating certain aerodynamic sound levels produced by large, horizontal-axis wind-turbine generators (WTG's) such as the DOE/NASA Mods-0, -0A, -1, and -2. This preliminary procedure is based upon very limited field data from the Mod-0. It postulates a noise component due to the (constant) rotation of the blades of the WTG, plus a wake-noise component that increases with the square of the power produced by the WTG. Mechanical sound from machinery, and low-frequency impulsive sounds produced by blade interaction with the wake of the support tower are not considered.

WIND ENERGY ENGINEERING

TURBINE DESIGN AND OPERATION

30586 (DOE/NASA/0002—80/2(Vol.2)) **MOD-2 wind turbine system concept and preliminary design report. Volume II. Detailed report.** (Boeing Engineering and Construction Co., Seattle, WA (USA)). Jul 1979. Contract AI01-79ET20305. 269p. (NASA-CR—159609(Vol.2)). NTIS, PC A12/MF A01.

This report documents the work accomplished during the Concept Design and Preliminary Design phases of NASA Contract DEN 3-2. These phases were designated the Task II Analyses and Design phases of the MOD-2 Wind Turbine System (WTS) project. The features and characteristics of the MOD-2 WTS evolved from a series of trade studies, inputs from NASA and several electric utility companies, and other analyses. Major features include an upwind rotor with a teetering hub and partial span pitch control; a planetary, light weight step-up gearbox driving a synchronous generator; and a low natural frequency (soft) steel shell tower. Supporting analyses and test data used in the design studies are presented. Methodology to assure accuracy of such analyses and data are included. Production and construction methods and development tests are reported to show the method by which BEC will assure that the specified design will perform as predicted, and that it will meet the maintenance and reliability standards established.

30587 (SAND—80-1639C) **Modal testing of the vertical axis wind turbine.** Miller, D.E.; Nord, A.R. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 23p. (CONF-800746—1). NTIS, PC A02/MF A01.

From Engineering foundation conference; Rindge, NH, USA (27 Jul 1980).

The VAWT is a 17-meter structure which has been tested in a variety of configurations. Early in the program there were three fiberglass blades reinforced with struts. A later configuration had two aluminum blades. Both of these have been tested by the modal analysis group. There is also a three-bladed aluminum structure which will be tested in the coming months. Test results are presented.

30588 (SAND—80-7015) **Vertical Axis Wind Turbine Foundation parameter study.** Lodde, P.F. (Sandia National Labs., Albuquerque, NM (USA)). Jul 1980. Contract AC04-76DP00789. 38p. NTIS, PC A03/MF A01.

The dynamic failure criterion governing the dimensions of prototype Vertical Axis Wind Turbine Foundations is treated as a variable parameter. The resulting change in foundation dimensions and costs is examined.

30589 (SERI/TR—98003-1) **Definitive generic study of augmented horizontal axis wind energy systems. Executive summary. Final report.** Lissaman, P.B.S.; Hibbs, B.; Walker, S.N.; Zambrano, T. (AeroVironment, Inc., Pasadena, CA (USA)). Apr 1979. Contract EG-77-C-01-4042. 75p. NTIS, PC A04/MF A01.

A method of increasing the power output of a wind turbine is to add an augmentor system which will act like a converging duct to increase the velocity at the turbine disk and thus increase the energy flux through the power extraction device. The cost-effectiveness of such systems depends upon the trade-off between the additional energy output and the added cost of the augmentor system. The report studies the cost-effectiveness of three different types of augmentors.

30590 (SERI/TR—98003-3) **Augmented horizontal axis wind energy systems assessment. Executive summary. Final report.** (Tetra Tech, Inc., Arlington, VA (USA)). Dec 1979. Contract EG-77-C-01-4042. 94p. NTIS, PC A05/MF A01.

Three horizontal axis augmented systems are critically examined, and the technical status, performance characteristics, and cost projections of these systems are evaluated. The purpose of the study is to determine whether these systems have the potential to be a cost effective energy resource. This assessment should provide guidance and direction for future programmatic efforts in the WEIS program. Although it is not meant to provide an exhaustive study of all aspects of these systems, the current status of horizontal axis augmented systems has been examined.

30591 (SERI/TR—98003-05) **Definitive generic study for sailwing wind energy systems. Non-technical summary report. Final report.** Hohenemser, K.H.; Swift, A.H.P.; Peters, D.A. (Washington Univ. Technology Associates, St. Louis, MO (USA)). Oct 1979. Contract EG-77-C-01-4042. 247p. (SERI/TR—8003-02; SERI/SP—8003-01). NTIS, PC A11/MF A01.

Information is presented concerning the aerodynamics of sailwings; tests with sailwing model rotors; performance and initial cost optimization of sailwing wind machines; structural integrity and durability of rotary sailwings; dynamics of sailwing wind machines; configurations of sailwing machines; potential improvements of rotary sailwings; and cost effectiveness of sailwing wind machines.

POWER CONVERSION SYSTEMS

REFER ALSO TO CITATION(S) 30727

30592 (DOE/ET/29100—11) **Security assessment of power systems including energy storage and with the integration of wind energy. Progress report, October 1, 1979-December 31, 1979.** Carroll, D.P.; Krause, P.C. (Purdue Univ., Lafayette, IN (USA). Energy Sources and Systems Simulation Lab.). Jan 1980. Contract EC-77-S-02-4206. 23p. NTIS, PC A02/MF A01.

Progress in wind energy studies is reported. During this quarter two areas were pursued: wind turbulence models and their effect on unsteady shaft torque of horizontal machines; and reduced order aerodynamic models of wind machines. (LCL)

SITE CHARACTERISTICS

30593 (PNL—3408) **Preliminary evaluation of wind energy potential: Cook Inlet area, Alaska.** Hiester, T.R. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jun 1980. Contract AC06-76RL01830. 103p. NTIS, PC A06/MF A01.

This report summarizes work on a project performed under contract to the Alaska Power Administration (APA). The objective of this research was to make a preliminary assessment of the wind energy potential for interconnection with the Cook Inlet area electric power transmission and distribution systems, to identify the most likely candidate regions (25 to 100 square miles each) for energy potential, and to recommend a monitoring program sufficient to quantify the potential.

30594 (RLO—2227-T24-78-2) **Vegetation as an indicator of high wind velocity. Wind power potential in the Pacific Northwest Coastal Region. Final report, February 15, 1978-June 14, 1978.** Hewson, E.W.; Wade, J.E.; Baker, R.W.; Heald, R.C. (Oregon State Univ., Corvallis (USA). Dept. of Atmospheric Science). Jun 1978. Contract EY-76-S-06-2227-024. 92p. NTIS, PC A05/MF A01.

Methodologies for evaluating wind power potential over a regional area are described as are the analyses performed upon the data for the region defined as the Pacific Northwest Coastal Region (PNWCR). This region is composed of the area west of the Cascade Mountains in Washington and Oregon. The analyses utilize existing summarized data, vegetative indicators of wind velocity, and inferred windflow patterns over characteristic coastal region terrain forms. The results of the analyses indicate that there are significant year-to-year variations of mean wind speed, but the annual mean wind speed may be adequately characterized after a recording period of three years or more.

ELECTRIC POWER ENGINEERING

POWER PLANTS AND POWER GENERATION

30595 **Preliminary evaluation of the industrial cogeneration potential in five San Francisco Bay Area counties. Consultant report.** Martineau, C. Jr.; Rodden, R.M. Sacramento, CA; California Energy Commission (1980). 60p. (P—500-80-026).

Estimates of the industrial cogeneration potential in five San Francisco Bay Area counties: Alameda, Contra Costa, Santa Clara, San Mateo, and San Francisco are developed. The estimates are developed using survey techniques including mailed questionaires and on-site visits. The following technical and economic feasibility criteria were used in screening potential industrial cogenerators; a heat demand rate criterion of 15,000 pounds of steam per hour and annual heat load factor of 0.60, which was determined by an after-tax return on investment requirement of 16%. Using these screening criteria, a survey was conducted at 75 industrial sites in the five county area, questionaires were received for 34 projects, and site visits were performed at 12 facilities. Based upon the above economic criteria there were 584 MW of viable cogeneration potential identified, about three quarters of which were found in oil refineries, chemical plants, or paper, plastic, or wallboard firms. The total industrial cogeneration capacity estimated for the five county area was 1334 MW. Extrapolating from this sample, this estimate involves a number of approximations and assumptions, and does not consider industrial growth in future years.

COOLING AND HEAT TRANSFER EQUIPMENT AND SYSTEMS

30596 (EPRI-CS—1474) **Wet/dry cooling for cycling steam-electric plants. Final report.** Guyer, E.C.; Brownell, D.L. (Dynatech R/D Co., Cambridge, MA (USA)). Aug 1980. 108p. NTIS, PC A06/MF A01.

The economics of water-conserving wet/dry cooling systems for steam-electric plants used for cycling or intermediate-load duty have been evaluated using a system simulation and design optimization computer model. Conclusions are based on the case-study evaluation of a separate wet and dry tower system which provides cooling for a nominal 500 MWe coal-fired plant for two site locations - Boston, Massachusetts, and Phoenix, Arizona. Historical utility load and meterological data which are coincidental have been used along representative utility system generation models to describe the economic and physical environment for the operation of the wet/dry systems. Optimum cooling system costs and designs assuming economically-dispatched cycling operation schedules are presented and compared to the costs and designs determined for base-load operation. All-wet and all-dry cooling systems have been evaluated in addition to wet/dry systems of different total annual water consumption. Consideration has been given to the impact of the design plant capacity factor on the incremental power production cost due to heat rejection, the selection of the steam turbine, the determined value of makeup water, and the economic consequences of operation at an off-design capacity factor.

POWER CYCLES

REFER ALSO TO CITATION(S) 30135, 30785

30597 (EPRI-AP—1393) **Gasification combined-cycle plant configuration studies. Final report.** Foster-Pegg, R.W.; Garland, R.V. (Westinghouse Electric Corp., Concordville, PA (USA)). Jun 1980. 180p. NTIS, PC A09/MF A01.

This report presents the results of a Texaco based coal gasification combined cycle configuration study in which current technology combustion turbines are applied with the ultimate objectives being: (1) determine a plant configuration that yields high efficiency; and (2) determine and quantify the influence of plant configuration and plant operating conditions on performance. Best efficiency, about 39% based on coal HHV (8840 Btu/kWh), is attained by integrating the gasification and gas cleanup system with the combined cycle. A reheat steam turbine operating at highest steam conditions practicable is also required along with a hot fuel gas expander which operates at 1000°F inlet temperature. The cycle can be simplified considerably by reducing the steam temperature to 950°F and deleting the fuel gas expander. These actions result in a heat rate increase of only about 2%. Further simplification is achieved by replacing the reheat steam turbine with a non-reheat machine which in turn simplifies the heat recovery steam generator configuration. The end result is an increase in heat rate of about 8% over the most efficient configuration, but the resultant heat rate is still lower than that expected for conventional coal fired power plants. One of the most challenging developmental efforts required to achieve a plant configuration that will operate at the highest efficiency relates to the integration of the gasification system with the combined cycle. A raw gas cooler is required which must operate in a hostile atmosphere at temperatures in the 1400°F to 2400°F range and must superheat and reheat steam to 1000°F. The difference in overall plant performance using a simple design gas cooler versus a complicated one amounts to a portion of the 2% increase in heat rate mentioned above.

WASTE-FUELED SYSTEMS

REFER ALSO TO CITATION(S) 30820, 30827, 30829, 30832, 30833

COMPONENTS

30598 (EPRI-CS—1445) **Centrifugal pump hydraulic instability. Final report.** Makay, E. (Energy Research and Consultants Corp., Morrisville, PA (USA)). Jun 1980. 72p. NTIS, PC A04/MF A01.

The principal objective was to define the causes of hydraulic instability in boiler feed pumps, explain their origins, and relate them to the geometries of a pump stage (e.g., inlet, impeller, diffuser or volute...). The approach is to examine the influence of each component of pump geometry on the flow path and flow mechanisms and thus eatimate the magnitudes and directions of hydraulically-induced forces on a pump rotor which influence dynamic response, pump performance, and critical speeds. The techniques and results of experiments on pump hydraulic forces are described and assessed to explain common frequency ranges. A method is developed for calculating radial hydraulic forces in a pump. The hydraulic mechanisms at work are listed, described, and related in turn to specific elements of pump stage geometry. Forces for the case in which the impeller is replaced with a solid mass are estimated. Recommendations are given for future work to measure and characterize the forces in various types of pump geometry. Two important findings are: (1) feedwater pumps must be designed for stable operation over the full range of possible flow rates, even at the cost of some reduction of efficiency at Best Operating Point; and (2) the complexities of flow within a pump stage are so great that every new design must be tested to determine its dynamic and performance characteristics over the full flow range.

30599 (EPRI-WS—78-114) **Low-pressure steam turbine blade failures. Workshop proceedings, Detroit, Michigan, June 28-29, 1978.** (Failure Analysis Associates, Palo Alto, CA (USA); Electric Power Research Inst., Palo Alto, CA (USA)). Jul 1980. 113p. NTIS, PC A06/MF A01.

Failures of blades in the low-pressure sections of steam turbines is costing the utility industry at least 265 million dollars/y. For this reason, a workshop was held to provide a forum for the exchange of information among utilities about blade failures and to recommend research and development to ensure increased blade life. Utility concerns involving circumstances of blade failures, corrective actions, inspection, reliability, blade replacement, and independent research were discussed. Current EPRI-sponsored R and D projects related to steam turbines were also described. The two most important themes that emerged were the desire for improved interutility communications about blade failures and the necessity for better solutions to blading problems. These issues are reflected in the following principal recommendations of the working group sessions: regularly scheduled workshops; a news bulletin and reporting system for improved information exchange about turbine failures; improved inspection procedures and requirements; standardization of blade design; better understanding of environment-material interactions; and in situ corrective actions for existing blades. The individual presentations, the ensuing discussions, and the recommendations of the three working groups are summarized.

WASTE HEAT UTILIZATION

REFER ALSO TO CITATION(S) 30817

OFF-PEAK ENERGY STORAGE

REFER ALSO TO CITATION(S) 30777

30600 (ANL-K—79-4917-1) **Evaluation of superconducting magnetic energy storage.** Little, A.D. (Little (Arthur D.), Inc., Cambridge, MA (USA)). Nov 1979. Contract W-31-109-ENG-38. 97p. NTIS, PC A05/MF A01.

Superconducting magnetic energy storage (SMES) systems differ from other storage systems presently in use, or considered for use, by the electric utility industry, principally because of the radically different technology involved. SMES also has certain unique advantages: it appears to be able to store and deliver energy at very high efficiency, and it can switch from the charge to discharge mode in a few tens of milliseconds. The combination of these two desirable characteristics distinguishes SMES from almost all other energy storage systems. This investigation was undertaken to discover if the nation and the electric utility industry might benefit sufficiently from the use of SMES systems to justify continued research and development support by DOE. At present, systems development is in a relatively early stage, and much component development for many of the major subsystems remains to be performed. It appears each SMES unit will be large and therefore expensive; also that the investment in research and development required to achieve final commercial success may be substantial.

FUELS

REFER ALSO TO CITATION(S) 30106

30601 **Conversion to coal and coal/oil firing.** Morrison, G.F. London, England; IEA Coal Research (1979). 69p. (ICTIS/TR—07).

This report reviews the literature on the conversion of power stations currently burning fuel oil or natural gas to coal or coal oil mixtures (COM). The influence of fuel type on power station design is discussed. It is concluded that only boilers designed originally for coal, but currently burning an alternate fuel, can be retrofitted to burn coal. Not all such boilers can be converted as sufficient space for coal handling and storage equipment may no longer be available. COM can be burned in the majority of boilers designed for coal or oil firing with only minor modifications to combustion equipment. Thus, COM provides a short term means of increasing the use of coal for power generation. The history of COM combustion and current research programs are discussed. Particular attention is given to COM stability, equipment design, and atmospheric emissions from COM combustion. References are given within the text to substantiate facts, to indicate further relevant published material and to give an indication of people and organizations with particular interests in specific fields of fuel substitution.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 30135, 31166, 31222, 31223

THERMAL EFFLUENTS

REFER ALSO TO CITATION(S) 31164

NOXIOUS GAS AND PARTICULATE ABATEMENT AND CONTROL

REFER ALSO TO CITATION(S) 30128, 30158, 30833

30602 **Mercury partitioning in a power plant plume and its influence on atmospheric removal mechanisms.** Lingerg, S.E. (Oak Ridge Natl Lab, Tenn). *Atmos. Environ.;* 14: No. 2, 227-231(1980).

This paper describes an investigation of mercury partitioning between particulate and vapor forms in the plume of a modern coal-fired power plant. Air samples were collected isokinetically in the plume of a major coal-fired power plant during helicopter flights. 33 refs.

30603 (DOE/EV/10142—1) **Benefit-cost framework for analysis of trace element emissions from coal-fired power plants.** (New Mexico

Univ., Albuquerque (USA). Dept. of Economics). Nov 1979. Contract AC02-79EV10142. 252p. NTIS, PC A12/MF A01.

The major conclusions of this report may be summarized in the following four points: (1) It is probable that atmospheric emissions of trace elements from Southwestern coal-fired power plants will not cause major problems over the next 20 years. But monitoring for trace element build-up (especially mercury, selenium, and arsenic) in the mountains of southern Colorado, Navajo Reservoir, and other local hot spots would be an important and desirable step. (2) It appears that damage from trace elements in disposed ash is more likely than damage from atmospheric trace element emissions. But whether damage from disposed ash will actually occur is highly uncertain. We recommend that additional research be conducted on the entire range of issues surrounding ash disposal. (3) In the area of legislation and regulation, there may be some need for review of regulations concerning trace element atmospheric emissions. Present regulation of ash disposal is very likely to need revision and extension. (4) Future research on the environmental problems of coal-fired power plants should place emphasis on atmospheric emissions of sulfur and nitrogen oxides; consequent problems of acid precipitation also need exploration. Environmental research on coal-fired power plants does not need to exclude other problems. But issues surrounding sulfur emissions, nitrogen emissions, sulfate transformations, and acid precipitation appear to merit major emphasis. Perhaps the most important aspect of the preceding list of conclusions is that more questions are raised than are answered. As work on the subject proceeded, it became apparent that an important task was to point future research in the right direction.

30604 (EPRI-CS—1439(Vol.1)) **Investigation of high SO_2 removal design and economics. Volume 1. Design. Final report.** Arnold, C.W. Jr.; Dickerman, J.C.; Hargrove, O.W.; Noblett, J.G. (Radian Corp., Austin, TX (USA)). Jun 1980. 112p. NTIS, PC A06/MF A01.

Two separate technical planning study reports were undertaken to predict the effect of potential increasingly strict SO_2 emission limits on the economics of wet scrubbing. The objective of Radian's work was to define representative cases and develop process designs and material balances that could be used to determine costs. The process designs were developed using a simulation computer program developed by the contractor. Cases were selected to span: coal - eastern and western; SO_2 removal - 84%, 93%, and 99%; and alkali - magnesia, limestone, and lime. The objective of SRI's work was to use Radian's results to develop a cost estimate for each case and then analyze the results. The latest vendor information was used to prepare the cost estimates. The major variables investigated were the liquid-to-gas ratio (L/G) in the scrubber and the volume of the process slurry holding tank. The former affects the SO_2 removal efficiency and the latter affects the scaling potential in the scrubber. Costs are significantly greater for higher SO_2 removals but they do not change by an order-of-magnitude as originally anticipated. Probably the most significant unanticipated result was the large effect that the Mg and Cl content of the scrubbing liquor has on system design and costs for lime and limestone systems. It is clear that this area should receive more attention in system design. Finally, although the magnesia system appears less expensive than conventional lime/limestone systems for high-sulfur coals, it is still not well developed and its reliability remains uncertain.

30605 (EPRI-CS—1439(Vol.2)) **Investigation of high SO_2 removal design and economics. Final report. Volume 2. Economics.** Oliver, E.D. (SRI International, Menlo Park, CA (USA)). Jun 1980. 65p. NTIS, PC A04/MF A01.

The Clean Air Act Amendments of 1977 require the Environmental Protection Agency to set new standards for control of sulfur dioxide emissions. SRI International estimated capital costs and incremental revenue requirements for flue gas desulfurization (FGD) to meet increasingly stringent SO_2 removal requirements. These costs were estimated by SRI for 14 conceptual designs based on process conditions and material balances determined by Radian Corporation. Analyses of these designs show the effects of various levels of SO_2 removal on the costs of burning eastern high-sulfur, high chlorine coal and western low-sulfur, low-chlorine (compliance) coal, using limestone, lime, and regenerative magnesia scrubbing. Total capital requirement for FGB ranges from $123 to $213/kW (January 1979 dollars), if 25% spare capacity is provided for reliability. The sulfur compliance coal chosen in this study does not require FGD under the old standard (520 ng/J or 1.2 lb SO_2 emission/million Btu), but the incremental 30-year levelized busbar cost is 8 to 9 mill/kWh if a high percentage of SO_2 removal is required. For eastern coal, revenue requirements increase less than 3 mill/kWh as removal requirements are tightened.

30606 (FE—2205-17) **Investigation of the mechanism of fly-ash formation in coal-fired utility boilers. Progress report, May 1, 1979-October 31, 1979.** Ulrich, G.D.; Palella, F. (New Hampshire Univ., Durham (USA). Dept. of Chemical Engineering). 31 Oct 1979. Contract AC01-76ET10619. 7p. NTIS, PC A02/MF A01.

Recent studies of fly-ash emitted from stationary combustion equipment suggest that substantial numbers of sub-micron particles are discharged even from units having electrostatic precipitators. This is the size fraction which is least efficiently collected and most damaging physiologically. Most previous work on ash formation has dealt with operating problems such as slagging and fouling caused by ash in the boiler itself. To attack both the operating and health problems in a more intelligent way, it is important to understand better the mechanism of ash formation and growth. The current status and objectives of this project are summarized. In the power plant studies, several probes, intended for use in Merrimack No. 1 and No. 2 boilers, have been designed and constructed. These are not water cooled, but rather depend on a refractory sheath and dilution air to keep temperatures low enough for survival of the metal components. Several tests have been conducted with alternate probe designs. The probes and experience to date are described. Another aspect of plant studies is the use of nuclepore filters to fractionate samples of product ash that have been dispersed in a liquid. This is part of an effort to separate and characterize fly-ash according to size and composition.

30607 (FE—2357-39(Vol.B)) **PFB coal fired combined cycle development program. Advanced hot gas cleanup concept evaluation (Task 4.3). Volume B. Developmental cyclone evaluation.** (General Electric Co., Schenectady, NY (USA). Energy Systems Programs Dept.). Feb 1980. Contract EX-76-C-01-2357. 73p. NTIS, PC A04/MF A01.

This report summarizes the results of cold flow model testing of a conventional reverse-flow cyclone containing several developmental features designed to improve its separative performance. The four advanced features evaluated were: Outlet Scroll Skimming - to remove particles from the high dust concentration region at the periphery of the outlet dust; Base Purge - to reduce reentrainment of dust from the disengagement hopper; Increased Outlet Duct Engagement - to reduce short-circuiting of the inlet dust into the outlet; and Vortex Shield - to stabilize the point of vortex attachment at the cyclone base and thus reduce base pickup. A schematic of the advanced cyclone, showing the various developmental features, is provided. The results of the cold flow experiments showed that substantial improvement (approximately 30% reduction in exhaust emission) could be obtained from outlet skimming or from increased engagement of the exhaust dust. Furthermore, the effects of these features are additive so that about 60% overall reduction in emissions could be achieved by incorporating both of these elements. On the other hand, the vortex shield and the base purge had little effect on the separative performance. Almost all of the experimental results exhibited strong electrostatic influence. At high flowrates, the separative performance of the cyclone decreased as the flowrate was reduced, as expected from cyclone theory. Although the improvements obtained with the developmental cyclone are significant, further improvements appear possible with the Air Shield cyclone and the Electrocyclone. Consequently, subsequent efforts under the CFCC program were focused on these concepts.

POWER TRANSMISSION AND DISTRIBUTION

30608 (DOE/ET/29299—T1) **Stochastic power flow modeling.** (General Electric Co., Schenectady, NY (USA)). Jun 1980. Contract AC01-78ET29299. 45p. NTIS, PC A03/MF A01.

The stochastic nature of customer demand and equipment failure on large interconnected electric power networks has produced a keen interest in the accurate modeling and analysis of the effects of probabilistic behavior on steady state power system operation. The principle avenue of approach has been to obtain a solution to the steady state network flow equations which adhere both to Kirchhoff's Laws and probabilistic laws, using either combinatorial or functional approximation techniques. Clearly the need of the present is to develop sound techniques for producing meaningful data to serve as input. This research has addressed this end and serves to bridge the gap between electric demand modeling, equipment failure analysis, etc., and the area of algorithm development. Therefore, the scope of this work lies squarely on developing an efficient means of producing sensible input information in the form of probability distributions for the many types of solution algorithms that have been developed. Two major areas of development are described in detail: a decomposition of stochastic processes which gives hope of stationarity, ergodicity, and perhaps even normality; and a powerful surrogate probability approach using proportions of time which allows the calculation of joint events from one dimensional probability spaces.

30609 (EPRI-EL—1430) **Gas/vapor- and fire-resistant transformers. Final report.** Moore, C.L.; Dakin, T.W.; Stewart, W.A. (Westinghouse Electric Corp., Sharon, PA (USA). Medium Power Transformer Div.). Jun 1980. 329p. NTIS, PC A15/MF A01.

This project responds to the serious need for a fire and explosion-resistant power transformer that can be produced at an acceptable cost while eliminating or reducing environmental concern. The objectives were to build three transformers with size,

performance, cost, and losses equivalent to their oil counterpart. After much development of materials and systems, a gas-insulated vapor cooled system was chosen for the 2500 kVA 95 BIL unit. An immersed system utilizing perchloroethylene (C_2Cl_4) with 25% transformer oil, was used for the 1000-kVA, 200-BIL network transformer and the 5000-kVA 200-BIL substation transformer. The materials and systems developed provide safer fire-resistant transformers at near the cost of oil-insulated units but with greatly reduced dependence on the petroleum industry.

30610 (PCTR—47-77) **Generalized stochastic power flow algorithm.** Sauer, P.W. (Purdue Univ., Lafayette, IN (USA). School of Electrical Engineering). Aug 1977. Contract AS02-77ET29102. 359p. (TR-EE—77-32). NTIS, PC A16/MF A01.

A general algorithm to determine the effects of uncertainty in bus load and generation on the output of conventional power flow analysis is presented. The use of statistical moments is presented and developed as a means for representing the stochastic process. Under this concept, statistical moments are used to describe the uncertainties and facilitate the calculations of single and multivariate probability density functions of input and output variables. Standard distributions need not be used, although the method is applicable for most distributions which have finite moments. The transformation of the uncertainty through the power flow equations is made by the expansion of the node equations in a multivariate Taylor series about an expected operating point. The series is truncated after the second order terms. Since the power flow equations are nonlinear, the expected values of output quantities are in general not the solution to the conventional load flow problem using expected values of input quantities. The second order transformation offers a correction vector and allows the consideration of larger uncertainties which have caused significant error in the current linear transformation algorithms. Voltage controlled busses are included with consideration of upper and lower limits. The finite reactive power available at generation sites and fixed ranges of transformer tap movement may have a significant effect on voltage and line power flow statistics. A method is given which considers limitation constraints in the evaluation of all output quantities. The bus voltages, line power flows, transformer taps, and generator reactive power requirements are described by their statistical moments. Their values are expressed in terms of the probability that they are above or below specified limits, and their expected values given that they do fall outside the limits.

30611 (SCI—5263(Vol.1)) **Development of advanced methods for planning electric energy distribution systems. Final report.** Ross, D.W.; Carson, M.; Cohen, A.I.; Dechamps, C.; Nuytten, R.; Vankelecom, J.; Peschon, J. (Systems Control, Inc., Palo Alto, CA (USA)). Feb 1980. Contract ET-78-C-03-1845. 144p. NTIS, PC A07/MF A01.

The research project, Development of Advanced Methods for Planning Electric Energy Distribution Systems is summarized. The research has concerned the development of new approaches to the planning of radial primary distribution systems. In particular, the research has addressed two problem areas: the development of optimization models for arranging or rearranging the radial structure of a system of feeders - for planning the normal operating configuration of the system; and the development of optimization models for reconfiguration (made possible by manual or automatic switching) of a radial system of feeders during either emergencies or planned outages. Details of the method of approach and of the models' development and testing are included in this volume. A separate Volume II provides computer program listings and supporting documentation.

30612 (SCI—5263(Vol.2)) **Development of advanced methods for planning electric energy distribution systems. Volume 2. Software documentation. Final report.** Ross, D.W.; Carson, M.; Nuytten, R. (Systems Control, Inc., Palo Alto, CA (USA)). Dec 1979. Contract ET-78-C-03-1845. 388p. NTIS, PC A17/MF A01.

This report supplements the Final Report, Development of Advanced Methods for Planning Electric Energy Distribution Systems, and documents the DISOPT-1 and SWITCH-1 software which resulted from the development work. Information is included on: some of the terminology used in the software development; the input data cards required for DISOPT-1 and SWITCH-1; the COMMON block structure for data within the two programs; the run control cards and the solution parameter cards for the two programs; sample DISOPT outputs; sample SWITCH outputs; and, finally, the FORTRAN listings of the programs.

DC SYSTEMS

30613 (EPRI-EL—1327) **Study of drifting, charged aerosols from HVDC lines. Final report.** Hoppel, W.A. (Hoppel (William A.), Fort Washington, MD (USA)). Jan 1980. 78p. NTIS, PC A06/MF A01.

A study of the mechanism by which atmospheric aerosol particles are charged in the vicinity of a unipolar HVDC line and a numerical analysis that predicts the magnitude of the wind-driven current carried by particulates was conducted. The major elements of the study are the following: equations for the rate of charging of particles in strong electric fields and unipolar ion environments are developed and numerical solutions are presented; the electrical mobility of charged particles is determined; numerical solutions to the equations that govern the electric field and ion density in the vicinity of a unipolar line for wind speeds of 0, 5, and 10 m/sec in the absence of aerosols are presented; and a numerical analysis of the magnitude of charge transferred to the aerosol as it is advected past the HVDC line as a function of wind speed is carried out for three aerosol size distribution models and three fog models. The results for a 400 kV unipolar HVDC line giving off 2.3 μamp per m predicts that 3 to 5% of the corona current will be transferred to aerosols in clean rural air, 4 to 12% in moderately polluted air, and possibly as much as 45% in highly polluted air; higher transfer rates are predicted for fogs. Downwind the space charge and resulting electric fields are one to two orders of magnitude greater than the fair-weather background values.

30614 (EPRI-EL—1343) **Electronic current transducer (ECT) for high-voltage dc lines. Final report.** Houston, J.M.; Peters, P.H. Jr.; Summerhayes, H.R. Jr.; Carlson, G.J.; Itani, A.M. (General Electric Co., Schenectady, NY (USA). Corporate Research and Development Dept.). Feb 1980. 178p. NTIS, PC A09/MF A01.

The development of a bipolar electronic current transducer (ECT) for measuring the current in a high-voltage dc (HVDC) power line at line potential is reported. The design and construction of a free-standing ECT for use on a 400-kV line having a nominal line current of 2000 A (1 pu) is described. Line current is measured by a 0.0001-Ω shunt whose voltage output is sampled by a 14-bit digital data link. The high-voltage interface between line and ground is traversed by optical fibers which carry digital light signals as far as 300 m to a control room where the digital signal is converted back to an analog representation of the shunt voltage. Two redundant electronic and optical data links are used in the prototype. Power to operate digital and optical electronics and temperature-controlling heaters at the line is supplied by a resistively and capacitively graded 10-stage cascade of ferrite-core transformers located inside the hollow, SF_6-filled, porcelain support insulator. The cascade is driven by an SCR (silicon-controlled-rectifier) inverter which supplies about 100 W of power at 30 kHz. Specification goals called for operation over the temperature range -40 to +50°C to an output accuracy of +-0.6% at 0.1 pu and +-0.3% between 0.3 pu and 1.0 pu. A frequency response greater than 370 Hz and a step response time of less than 2 ms was desired. Initial tests indicate that these goals have been met in the prototype structure. The unit is now installed and being evaluated at the Sylmar converter station of the HVDC Pacific Intertie in California.

30615 (EPRI-EL—1349) **Light-triggered thyristors for electric power systems (Phase 2). Interim report.** Temple, V.A.K.; Jackson, B. (General Electric Co., Schenectady, NY (USA). Corporate Research and Development Dept.). Mar 1980. 212p. NTIS, PC A10/MF A01.

The development of light triggered thyristors suitable for HVDC applications is discussed. Three devices were constructed with 5, 4, and 2 amplifying stages, respectively, with several subvariations. Of these the 4 amplifying stage GE3 type D device and all variations (A, B, and C) of the two stage GE4 design proved sufficiently reliable for the replacement of the normal, electrically triggered 2.6 kV HVDC cell. These devices proved the usefulness of the n^+ alignment band, a feature design to ensure even turn-on, and the interrupted n^+ metal, a feature to enhance rapid spreading away from the initial turn-on line. Important device characteristics other than a typical 160A/μsec or better di/dt at 105°C and 1800 volts include the following: (1) typical forward breakdown voltage of 2900 volts; (2) typical reverse breakdown voltage of 3100 volts; (3) dv/dt capability of 2000V/μsec to 2200 volts; (4) forward drop at 105°C, 1000 amperes of 1.3 volts and, finally, (5) a typical photo threshold of 10 to 20 nanojoules of incident photo energy. Surge capability and other device ratings are similar to the original electrically fired device. It is also significant that both the fabrication and packaging of these devices took place in a production facility and that the light triggered thyristor could be fabricated with the same process, apart from the extra sensitivity etch, as the regular electrically triggered device. Further, the package is a relatively simple one which requires only a few cents worth of extra parts.

30616 (SRD—78-149) **Development of a hvdc prototype breaker. Final report, November 5, 1975-October 1, 1978.** (General Electric Co., Schenectady, NY (USA). Corporate Research and Development Dept.). 1978. Contract AC01-76ET29054. 296p. NTIS, PC A13/MF A01.

The significant design features of a high-voltage dc (hvdc) circuit breaker based on the commutation concept have been developed. Tests of components indicate the breaker is capable of interrupting a fault current of 10 kA on a 400 kV system and absorbing up to 10 MJ of system energy without generating more than 1.6 per unit (P.U.) voltage on the system. Interactions of the breaker with a

three-terminal network were studied, using a system simulator. An ultrafast hydraulic actuator system was developed for this program. It enables the breaker, which is independent of terminal actions, to respond rapidly to a trip signal and to initiate the current limiting process within 5 ms after receipt of a trip signal. A new hydraulic valve, operated by a repulsion coil, minimizes the delay before motion begins. Interruption will occur in series-connected vacuum interrupters chosen because of their unique ability to interrupt high dI/dt before current zero followed by a high rate of rise of recovery voltage (RRRV) with a short contact gap. A 400 kV circuit breaker is estimated to require eight breaks in series. Only a single break has been tested as part of this program because of the scale and cost required for multibreak tests. System energy will be absorbed by zinc-oxide-based surge suppressors included as an integral part of the breaker. Their extremely nonlinear current-voltage characteristic allows them to be operated with no series gaps. The overall design is envisioned as a dead tank type using pressurized SF_6 gas as a dielectric medium. The actuator and all contol functions are located at ground potential, with easy access for inspection or adjustment. Operational specifications such as duty cycle and operating temperature range have been carried over from NEMA standards for ac power circuit breakers where applicable.

SUPERCONDUCTING AND CRYOGENIC SYSTEMS

30617 (BNL—27854) **Cooling and electrical excitation of 100 m superconducting power transmission cables.** Forsyth, E.B.; Gibbs, R.J.; Jensen, J.E.; McNernery, A.J. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract AC02-76CH00016. 5p. (CONF-800631—9). NTIS, PC A02/MF A01.

From 8. international cryogenic engineering conference; Genoa, Italy (3 Jun 1980).

Portions of document are illegible.

The design of a test facility for superconducting power transmission cables is described. The cryogenic portion consists of a screw compressor, cold box with turbine expanders, 100 m of transfer line and 100 m of cable enclosure. The complete cryogenic system has been operated and performance figures are given. The cables will be operated at voltage and current by electrical equipment which has mostly been installed and tested. The interface between the low-temperature cables and the outside are four termination bushings which are under construction; a brief description is included.

NUCLEAR POWER PLANTS

REFER ALSO TO CITATION(S) 30761

30618 (DOE/ET/32017—T1) **Public concerns and alternative nuclear power systems.** Mayo, L.H. (George Washington Univ., Washington, DC (USA)). Feb 1980. Contract AS01-77ET32017. 135p. NTIS, PC A07/MF A01.

The basic task undertaken in this study was to assess the relative public acceptability of three general types of nuclear power systems as alternatives to the existing Light Water Reactor (LWR) system. Concerns registered toward nuclear power constituted the basic data for this assessment. The primary measure adopted for determining the significance of concerns was the degree of difficulty posed by the concern to the nuclear power decisional structure in the establishment and maintenance of norms to control risks or to advance intended energy objectives. Alleviations or exacerbations of concern resulting from particular attributes of alternative systems were measured from an LWR baseline.

30619 **Safeguards and security as a dynamic process.** Isaacs, T.H. (Dept. of Energy, Washington, DC). *Trans. Am. Nucl. Soc.;* **33**: 731(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30620 **Intrusion detection systems.** Williams, J.D. (Sandia Labs., Albuquerque, NM). *Trans. Am. Nucl. Soc.;* **33**: 733-734(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30621 **SNAP: a tool for nuclear physical protection system modeling.** Grant, F.H. III (Pritsker and Associates, Inc., West Lafayete, IN); Engi, D. *Trans. Am. Nucl. Soc.;* **33**: 734-735(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED

REFER ALSO TO CITATION(S) 30706, 30711, 30712, 30713, 30717, 30718, 30722, 30723, 30724, 30725

30622 (COO—2985-23) **Dilute chemical decontamination program. Quarterly report 2, January-March 1978.** Anstine, L.D. (General Electric Co., Pleasanton, CA (USA). Vallecitos Nuclear Center). Jun 1978. Contract AC02-76ET34203. 53p. (NEDC—12705-2). NTIS, PC A04/MF A01.

Effects of reagent concentration, pH, temperature, and reducing agents on the dissolution rate of BWR out-of-core oxide films in the three candidate reagents were evaluated. Preliminary dissolution tests with BWR fuel deposits indicate that 0.01 M EDTA, NTA, and citric acid with 0.01 M ascorbic acid are capable of dissolving greater than 70% of the oxide film in less than 10 hours. The rate in 0.01 M oxalic acid is slightly slower. Equilibria for the distribution of Fe^{+3}, Fe^{+2}, and Co^{+2} between solutions of oxalic acid, EDTA, and NTA, and cation and anion resins indicate that oxalic acid and NTA systems can be regenerated; while EDTA systems cannot be regenerated. Ferric ion significantly reduces the adsorption rate of all reagents. The adsorption rate for the EDTA and oxalate complexes can be accelerated by decreasing the ratio of cation to anion resin. It appears that the oxalate system will require the smallest quantity of resin for total removal, with the NTA and EDTA systems requiring 30 to 60% more resin. The crystal structure of the Brunswick-2 and Monticello fuel deposits was essentially 100% αFe_2O_3. The fuel deposits from Brunswick-2 and Monticello were determined to consist of particles of two different sizes. The preliminary Dresden-2 materials survey of the reactor pressure vessel and recirculation system was completed. This survey was utilized to prepare the materials list for the corrosion test plan. 28 figures, 7 tables.

30623 (GEAP—25163-2) **Demonstration of fuel resistant to pellet-cladding interaction: Phase 2. Second semiannual report, July-December 1979.** Rosenbaum, H.S. (comp.). (General Electric Co., Schenectady, NY (USA)). Mar 1980. Contract AC02-77ET34001. 91p. NTIS, PC A05/MF A01.

This program has as its ultimate objective the demonstration of an advanced fuel design that is resistant to the failure mechanism known as fuel pellet-cladding interaction (PCI). Two fuel concepts are being developed for possible demonstration within this program: (a) Cu-barrier fuel and (b) Zr-liner fuel. In the current report period the nuclear design of the demonstration was begun. The design calls for 132 bundles of barrier fuel to be inserted into the core of Quad Cities Unit 2 at the beginning of Cycle 6. Laboratory and in-reactor tests were started to evaluate the stability of Zr-liner fuel which remains in service after a defect has occurred which allows water to enter the rod. Results to date on intentionally defected fuel indicate that the Zr-liner fuel is not rapidly degraded despite ingress of water.

30624 (UCRL—82118) **Effects of torus wall flexibility on forces in the Mark I BWR pressure suppression system under SRV T-quencher loading.** Holman, G.S.; Lu, S.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Jan 1980. Contract W-7405-ENG-48. 25p. (CONF-800804—12). NTIS, PC A02/MF A01.

From ASME century 2 emerging technology conference; San Francisco, CA, USA (10 Aug 1980).

This report describes a series of extended analyses requested by the US Nuclear Regulatory Commission to provide qualified understanding of possible fluid/structure interaction (FSI) effects for SRV teequencher test results. Three input pulses with total impulses varying by up to a factor of five are applied to two-dimensional finite-element models of the Mark I torus with shell diameter-to-thickness ratios of 0, 300, and 600. The results of these analyses support earlier conclusions that increased wall flexibility enhances attenuation of hydrodynamic loads and furthermore indicate that the magnitude of the attenuation is only weakly affected by the total impulse of the bubble pressure time-history.

30625 **Influence of in-service inspection on piping integrity of BWRs.** Harris, D.O. (Science Applications, Inc., Palo Alto, CA). *Trans. Am. Nucl. Soc.;* **33**: 750-751(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30626 **Radioactivity releases in boiling water reactors reported in the LER file.** Azarm, M.A.; Dickey, J.M.; Hall, R.E. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.;* **33**: 754-756(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30627 **Survey and classification of LWR maintenance problems for remote technology applications.** Dugan, E.T.; Ohanian, M.J.

(Univ. of Florida, Gainesville). *Trans. Am. Nucl. Soc.;* **33**: 885-887(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30628 Analytic derivation of a subchannel void-drift model. Drew, D.A.; Lahey, R.T. Jr. (Rensselaer Polytechnic Inst., Troy, NY). *Trans. Am. Nucl. Soc.;* **33**: 975-976(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED

REFER ALSO TO CITATION(S) 30295, 30627, 30661, 30672, 30673, 30674, 30703, 30704, 30709, 30710, 30711, 30712, 30713, 30716, 30717, 30718, 30719, 30720, 30721, 30724, 30725, 30909

30629 (BAW—1532-2) **Development of an extended-burnup Mark B design. Second semiannual progress report, January-June 1979.** (Babcock and Wilcox Co., Lynchburg, VA (USA)). Nov 1979. Contract AC02-78ET34213. 67p. NTIS, PC A04/MF A01.

The immediate goal of the DOE/AP and L/B and W project is to extend the burnup of light water reactor fuel assemblies beyond present limits to 50,000 MWd/mtU batch average burnup. Fuel management plans and fuel designs are being directed to attain the increased burnup limits. Lead-test assemblies of extended-burnup designs will be manufactured, irradiated in a commercial pressurized water reactor, and examined to support extended-burnup fuel cycles. This report, covering the period from January through June 1979, is the second semiannual progress report for the program. Efforts have included analyses of extended-burnup fuel cycles, developed of both annular fuel pellet and segmented rod designs, and design of a nondestructive post-irradiation examination system.

30630 (DLCS—5000180) **[Shippingport Atomic Power Station]. Quarterly operating report, first quarter 1980.** (Duquesne Light Co., Shippingport, PA (USA)). 1980. Contract AC11-76PN00292. 30p. NTIS, PC A03/MF A01.

At the beginning of the first quarter of 1980, the Shippingport Atomic Power Station was operating with the 1A, 1B, 1C, and 1D reactor coolant loops and the 1AC and 1BD purification loops in service. During the quarter, the Station was operated for the Duquesne Light Company System in the base mode operation. No swing load operations were conducted this quarter; however, several 15% reactor power cycles were performed for training. The LWBR core has generated 15,129.91 EFPH from startup through the end of the quarter.

30631 (DOE/ET/04712—1) **Development of an extended-burnup Mark B design. First semi-annual progress report, July-December 1978. Report BAW-1532-1.** (Babcock and Wilcox Co., Lynchburg, VA (USA)). Oct 1979. Contract AC02-78ET34213. 160p. NTIS, PC A08/MF A01.

The primary objective of this program is to develop and demonstrate an improved PWR fuel assembly design capable of batch average burnups of 45,000-50,000 MWd/mtU. To accomplish this, a number of technical areas must be investigated to verify acceptable extended-burnup fuel performance. This report is the first semi-annual progress report for the program, and it describes work performed during the July-December 1978 time period. Efforts during this period included the definition of a preliminary design for a high-burnup fuel rod, physics analyses of extended-burnup fuel cycles, studies of the physics characteristics of changes in fuel assembly metal-to-water ratios, and development of a design concept for post-irradiation examination equipment to be utilized in examining high-burnup lead-test assemblies.

30632 (PNL-TR—404) **Dosimetry of damage in the simulated PWR vessel of the ORNL reactor.** Alberman, A.; Benoist, M.; Thierry, M. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Services des Piles). 4 Jun 1980. Translation of D.CEN/SPS/EAR/80/009, January 1980. 25p. NTIS, PC A02/MF A01.

The measurements of damage fluences by the GAMIN and TUNGSTENE techniques have proven to be in very close agreement. Evaluation of the steel irradiation positions at 1/4 thickness shows that the damage effectiveness per unit of nickel flux is 20 to 30% higher than at the surveillance position, depending on the model. Nevertheless, any effect which may exist due to flux level (1/10) would predominate. Adjustment of the irradiation to obtain the same damage fluence (dpa) requires the ratio of durations to be 11. Measurement of the damage at the 3/4 thickness position, where the spectrum is of very low energy, reveals very high damage/activation ratios and ought to make it possible to validate the transport codes (ANISN type) in this geometry.

30633 Irradiated fuel inspection station. Bernacki, T.R.; Brookins, R.H. (Combustion Engineering, Inc., Windsor, CT). *Trans. Am. Nucl. Soc.;* **33**: 889(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30634 Remote operations on irradiated PWR fuel assemblies. Davis, H.H.; Dudley, B.C. (Babcock and Wilcox Co., Lynchburg, VA). *Trans. Am. Nucl. Soc.;* **33**: 889-890(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

POWER REACTORS, NON-BREEDING, GRAPHITE MODERATED

REFER ALSO TO CITATION(S) 30240, 30667, 30668, 30670, 30707, 30919

30635 (CONF-800564—1) **Estimation and control in HTGR fuel rod fabrication.** Downing, D.J.; Bailey, M.J. (Oak Ridge National Lab., TN (USA); Tennessee Univ., Knoxville (USA). Dept. of Electrical Engineering). 1980. Contract W-7405-ENG-26. 5p. NTIS, PC A02/MF A01.

From 12. annual symposium on system theory; Virginia Beach, VA, USA (19 May 1980).

A control algorithm has been derived for a HTGR Fuel Rod Fabrication Process utilizing the method of Box and Jenkins. The estimator is a Kalman filter and is compared with a Least Square estimator and a standard control chart. The effects of system delays are presented.

30636 (GA-A—15605) **Numerical accuracy of linear triangular finite elements in modeling multi-holed structures.** Sullivan, R.M.; Griffen, J.E. (General Atomic Co., San Diego, CA (USA)). Jun 1980. Contract AT03-76ET35300. 132p. NTIS, PC A07/MF A01.

A study has been performed to quantify the accuracy of linear triangular finite elements for modeling temperature and stress fields in structures with multiple holes. The purpose of the study was to evaluate the use of these elements for the analysis of HTGR fuel blocks, which may contain up to 325 holes. Since an accurate full scale analysis was not feasible with existing methods, a representative small scale benchmark problem containing only seven holes was selected. The finite element codes used in this study were TEPC-2D for thermal analysis and SAFIRE for stress analysis. It was concluded that linear triangular finite elements are too inefficient for this application. An accurate analysis of stresses in HTGR fuel blocks will require the use of higher order elements, such as the 8-node quadrilaterals in the new TWOD code.

30637 (GA-A—15756) **Heat exchanger design considerations for high temperature gas-cooled reactor (HTGR) plants.** McDonald, C.F.; Vrable, D.L.; Van Hagan, T.H.; King, J.H.; Spring, A.H. (General Atomic Co., San Diego, CA (USA)). Feb 1980. Contract AT03-76SF70046;AT03-76SF71061. 16p. (CONF-800723—10). NTIS, PC A02/MF A01.

From 19. national heat transfer conference; Orlando, FL, USA (27 Jul 1980).

Various aspects of the high-temperature heat exchanger conceptual designs for the gas turbine (HTGR-GT) and process heat (HTGR-PH) plants are discussed. Topics include technology background, heat exchanger types, surface geometry, thermal sizing, performance, material selection, mechanical design, fabrication, and the systems-related impact of installation and integration of the units in the prestressed concrete reactor vessel. The impact of future technology developments, such as the utilization of nonmetallic materials and advanced heat exchanger surface geometries and methods of construction, is also discussed.

30638 (GA-A—15842) **HTGR generic technology program. Semiannual report ending March 31, 1980.** (General Atomic Co., San Diego, CA (USA)). May 1980. Contract AT03-76ET35300. 359p. NTIS, PC A16/MF A01.

This document reports the technical accomplishments on the HTGR Generic Technology Program at General Atomic during the first half of FY-80. It covers a period when the design direction of the National HTGR Program is in the process of an overall review. The HTGR Generic Technology Program activities have continued so as to provide the basic technology required for all HTGR applications. The activities include the need to develop an MEU fuel and the need to qualify materials and components for the higher temperatures of the gas turbine and process heat plants.

30639 (ORNL/TM—7207) **Conceptual design characteristics of a denatured molten-salt reactor with once-through fueling.** Engel, J.R.;

Bauman, H.F.; Dearing, J.F.; Grimes, W.R.; McCoy, H.E.; Rhoades, W.A. (Oak Ridge National Lab., TN (USA)). Jul 1980. Contract W-7405-ENG-26. 160p. NTIS, PC A08/MF A01.

A study was made to examine the conceptual feasibility of a molten-salt power reactor fueled with denatured ^{235}U and operated with a minimum of chemical processing. Because such a reactor would not have a positive breeding gain, reductions in the fuel conversion ratio were allowed in the design to achieve other potentially favorable characteristics for the reactor. A conceptual core design was developed in which the power density was low enough to allow a 30-year life expectancy of the moderator graphite with a fluence limit of 3×10^{26} neutrons/m^2 ($E > 50$ keV). This reactor could be made critical with about 3450 kg of 20% enriched ^{235}U and operated for 30 years with routine additions of denatured ^{235}U and no chemical processing for removal of fission products. A review of the chemical considerations assoicated with the conceptual fuel cycle indicates that no substantial difficulties would be expected if the soluble fission products and higher actinides were allowed to remain in the fuel salt for the life of the plant.

30640 Afterheat predictions and measurements for the Fort St. Vrain HTGR. Petersen, J.F.; Bender, D.M.; Engholm, B.A. (General Atomic Co., San Diego, CA). *Trans. Am. Nucl. Soc.;* **33**: 757-758(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30641 Development of surveillance robot for dimensional and visual ispection of fuel and reflector elements of the Fort St. Vrain HTGR. Wallroth, C.F.; Marsh, N.I.; Miller, C.M.; Saurwein, J.J.; Smith, T.L. (General Atomic Co., San Diego, CA). *Trans. Am. Nucl. Soc.;* **33**: 890-891(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

POWER REACTORS, BREEDING

REFER ALSO TO CITATION(S) 30630, 30671, 30701, 30702, 30708, 30715, 30875, 30900, 31304

30642 (DOE-tr—124) **Creep and stress-rupture behavior of internally pressurized tubes made from austenitic stainless steel X10 NiCrMoTiB 15 15 (Material No. 1.4970, Melt 8-22075).** Schaefer, L.; Polifka, F.; Kempe, H. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Material- und Festkoerperforschung). [nd]. Translation of KFK—2543, April 1978. 47p. NTIS (US Sales Only), PC A03/MF A01.

Work performed under United States-W. Germany Fast Reactor Exchange Program.

Creep and stress-rupture tests have been performed at 600, 650, 700, and 750°C on tubes with two different thermal-mechanical treatments made from the austenitic stainless steel X10 NiCrMoTiB 15 15 (Material-No. 1.4970, Chg. 8-22075). The tubes with the SNR 300, MK-II dimensions were loaded by internal pressure, and the creep strain was measured continuously. The results are presented in form of creep curves, stress-time-to-rupture curves, and curves for a creep limit. The average and minimum creep rates as a function of the applied stress have been evaluated and are described with a creep law analogous to Norton's creep law.

30643 (ANL—80-26) **Lagrangian three-dimensional finite-element formulation for the nonlinear fluid-structural response of reactor components.** Kulak, R.F.; Fiala, C. (Argonne National Lab., IL (USA)). Mar 1980. Contract W-31-109-ENG-38. 47p. NTIS, PC A03/MF A01.

This report presents the formulations used in the NEPTUNE code. Specifically, it describes the finite-element formulation of a three-dimensional hexahedral element for simulating the behavior of either fluid or solid continua. Since the newly developed hexahedral element and the original triangular plate element are finite elements, they are compatible in the sense that they can be combined arbitrarily to simulate complex reactor components in three-dimensional space. Because rate-type constitutive relations are used in conjunction with a velocity-strain tensor, the formulation is applicable to large deformation problems. This development can be used to simulate (1) the fluid adjacent to reactor components and (2) the concrete fill found in large reactor head closures.

30644 Past and present role of fast breeder reactors in the United States of America. Smith, R.R.; Cissel, D.W. (Argonne National Lab., Idaho Falls, ID (USA)). pp 29-56 of Design, construction and operating experience of demonstration LMFBRs. Vienna, Austria; International Atomic Energy Agency (1978).

From Symposium on design, construction and operating experience of demonstration liquid metal fast breeder reactors; Bologna, Italy (10 Apr 1978).

Of the many American facilities dedicated to fast reactor technology, six qualify as liquid-metal-cooled fast reactors. All of these satisfy the following criteria: an unmoderated neutron spectrum, highly enriched fuel material, substantial heat production, and the use of a liquid metal coolant. These include the following: EBR-I, Clementine, LAMPRE, EBR-II, EFFBR, and SEFOR. Collectively, these facilities encompass all of the more important features of liquid-metal-cooled fast reactor technology. Coolant types range from mercury in Clementine, to NaK in EBR-I, and sodium in the others. Fuels include enriched-uranium metallic alloys in EBR-I, EBR-II, and EFFBR; metallic plutonium in Clementine; molten plutonium alloy in LAMPRE; and a mixed UO_2-PuO_2 ceramic in SEFOR. Heat removal technique ranges from air-blast cooling in LAMPRE and SEFOR, steam-electrical generation in EBR-I, EBR-II, and EFFBR, to a mercury-to-water heat dump in Clementine. Operational experience with such diverse systems has contributed considerably to the US breeder reactor programme. Each of the six systems is described from the viewpoints of purpose, history, design, and operation. Attempts are made to limit descriptive material to the most important features. The reader is referred to a few select references for additional information.

30645 (CONF-800607—39) **Analysis of the thorium axial blanket experiments in the PROTEUS reactor.** White, J.R.; Ingersoll, D.T.; Schmocker, U. (Oak Ridge National Lab., TN (USA); Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen (Switzerland)). 1980. Contract W-7405-ENG-26. 7p. NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; Las Vegas, NV, USA (8 Jun 1980).

An extensive program of reactor physics experiments in GCFR fuel pin lattices has been completed recently at the PROTEUS critical facility located at EIR laboratory in Switzerland. The PROTEUS reactor consists of a central test zone surrounded by a uranium buffer and thermal driver region. The test lattices included a PuO_2/UO_2 fuel region with internal and axial blankets of UO_2, ThO_2, and thorium metal. Detailed analysis of the thorium-bearing lattices has been performed at EIR and at ORNL in order to validate nuclear data and methods used for reactor physics analysis of advanced GCFR designs.

30646 (DOE/CEA/BMFT—15) **Debene sodium test facility profiles.** (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bergisch Gladbach (Germany, F.R.)). Oct 1979. 56p. NTIS (US Sales Only), PC A04/MF A01.

Work performed under United States-CEA/BMFT Fast Reactor Exchange Program.

The facilities for component testing in sodium at INTERATOM and the Netherlands are described.

30647 (EGG-EA—5163) **SHRS RRCL selection methodology.** Trainer, J.E.; Delaney, H.M. (EG and G Idaho, Inc., Idaho Falls (USA)). May 1980. Contract AC07-76ID01570. 35p. NTIS, PC A03/MF A01.

The CRBRP Safety Related Reliability Program requires a listing of those design items whose failure would impact the ability of the plant for a safe shutdown or shutdown heat removal mission. This listing is referred to as the Reliability Related Components List (RRCL) and heretofore, has been based on sound engineering judgement. As a check for completeness and as a means of providing a probabilistic-based rationale for component selection, this report presents a methodology by which this selection can be made for each of the decay heat removal loops comprising the Shutdown Heat Removal System (SHRS) using existing EG and G fault tree models.

30648 (JAPFNR—465) **Measurements of energy release rates of fission products (III). PNC-J—260-79-02-Tr.** Akiyama, M.; Sakata, K.; Oka, Y.; An, S.; Furuhashi, A. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan); Tokyo Univ. (Japan). Faculty of Engineering). Jul 1979. 27p. NTIS (US Sales Only), PC A03/MF A01.

Work performed under United States-Japanese Fast Reactor Exchange Program.

The gamma-ray energy release rates of the fission-product have been measured for the fast-neutron fission of ^{235}U, ^{238}U,NU and ^{232}Th. The samples have been irradiated at fast neutron source reactor YAYOI of University of Tokyo. The gamma-ray spectra have been measured by NaI scintillation spectrometer. The response matrix of this spectrometer was made experimentally using the standard gamma-ray sources. The gamma-ray energy spectra have been obtained by unfolding the measured pulse height distributions. The gamma-ray energy release rates have been obtained to integrate the gamma-ray spectra. These experimental results of the gamma-ray energy release rates for those samples except ^{235}U sample agreed with the results of the summation calculations.

30649 (KFK—2787) **TP2, a computer program for the calculation of reactivity and kinetic parameters by the two-dimensional**

neutron transport perturbation theory. Kobayashi, K. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik). Jul 1979. 62p. NTIS (US Sales Only), PC A04/MF A01.

Work performed under United States-W. Germany Fast Reactor Exchange Program.

TP2 is a FORTRAN-IV program for the calculation of the reactivity, effective delayed neutron fractions and mean generation time by the perturbation theory using the angular fluxes calculated by a two-dimensional S/sub n/ transport code. Group cross sections, delayed neutron fractions and spectra, isotope dependent prompt neutron spectrum, and direct and adjoint angular fluxes are read from disk files. This code can treat x-y, r-z, and r-θ geometry in two dimensions, and the code structure is nearly the same as the TP1 code for the one-dimensional geometry.

30650 (KFK—2789) **HEXAGA-II-120, -60, -30: two-dimensional multi-group neutron diffusion programmes for a uniform triangular mesh with arbitrary group scattering.** Woznicki, Z. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik). Jun 1979. 110p. NTIS (US Sales Only), PC A06/MF A01.

Work performed under United States-W. Germany Fast Reactor Exchange Program.

This report presents the AGA two-sweep iterative methods belonging to the family of factorization techniques in their practical application in the HEXAGA-II two-dimensional program to obtain the numerical solution to the multi-group, time-independent, (real and/or adjoint) neutron diffusion equations for a fine uniform triangular mesh. An arbitrary group scattering model is permitted. The report written for the users provides the description of input and output. The use of HEXAGA-II is illustrated by two sample reactor problems.

30651 (LA-UR—80-642) **Structural confinement and safety design of a fast-reactor core.** Ju, F.D.; Bennett, J.G. (New Mexico Univ., Albuquerque (USA); Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 22p. (CONF-800804—15). NTIS, PC A02/MF A01.

From ASME century 2 emerging technology conference; San Francisco, CA, USA (10 Aug 1980).

In certain fast-reactor designs, the core is an assemblage of a large number of containers of long, hexagonal, hollow cylinders mounted vertically. These so-called hex-cans sit individually on coolant nozzles held down by their own weight, and are held as a group laterally at two levels by two constraint rings. In the analysis, it is observed that the large number of hex-cans and the distribution of the temperature field are such that the cross section of the reactor core can be treated as in a locally uniform dilatational field. An approximate equation was developed relating the plane deformation of a hollow hex cylinder to the global lateral pressure. The cylinder constitutive equation is then used to determine an equivalent stiffness for a solid hex cylinder that is to have the same deformation as the given hex-can. The entire planar core region is then analyzed as a homogeneous medium of the equivalent stiffness. The method was applied to the core confinement design for a fast reactor. The thermoelastic solution was then applied to a relatively simpler configuration than the actual case to give a measure of the lateral pressure.

30652 (PNL—3337) **LMFBR in-core thermal-hydraulics: the state of the art and US research and development needs.** Khan, E.U. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1980. Contract EY-76-C-06-1830. 364p. NTIS, PC A16/MF A01.

A detailed critical review is presented of the literature relevant to predicting coolant flow and temperature fields in LMFBR core assemblies for nominal and non-nominal rod bundle geometries and reactor operating conditions. The review covers existing thermal-hydraulic models, computational methods, and experimental data useful for the design of an LMFBR core. The literature search made for this review included publications listed by Nuclear Science Abstracts and Energy Data Base as well as papers presented at key nuclear conferences. Based on this extensive review, the report discusses the accuracy with which the models predict flow and temperature fields in rod assemblies, identifying areas where analytical, experimental, and model development needs exist.

30653 (SAND—80-0432) **Calculation of the response of cylindrical targets to collimated beams of particles using one-dimensional adjoint transport techniques.** Dupree, S.A. (Sandia National Labs., Albuquerque, NM (USA)). Jun 1980. Contract AC04-76DP00789. 20p. NTIS, PC A02/MF A01.

The use of adjoint techniques to determine the interaction of externally incident collimated beams of particles with cylindrical targets is a convenient means of examining a class of problems important in radiation transport studies. The theory relevant to such applications is derived, and a simple example involving a fissioning target is discussed. Results from both discrete ordinates and Monte Carlo transport-code calculations are presented, and comparisons are made with results obtained from forward calculations. The accuracy of the discrete ordinates adjoint results depends on the order of angular quadrature used in the calculation. Reasonable accuracy by using EQN quadratures can be expected from order S_{16} or higher.

30654 (DOE-tr—117) **Development of analytical techniques for aerosol and fission products release from hot and boiling sodium pools.** Mainka, E.; Coerdt, W.; Hartmann, M.; Mueller, H.G. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Radiochemie). Aug 1979. Translation of KFK—2569, March 1978. 22p. NTIS (US Sales Only), PC A02/MF A01.

Work performed under United States-W. Germany Fast Reactor Exchange Program.

A method of sodium determination was developed which is simple, fast, and easily automated. It was further shown that the techniques of OH, CO_2, and HCO_3 analysis used in water technology are equally applicable to the problem treated here. An analytical technique based on atomic absorption spectrometry was developed allowing monitoring of fission products released. Random samples taken in the Cs determination by activation analysis and in the Sr determination using x-ray fluorescence spectroscopy were compared. The capabilities of the method used were demonstrated for these fission products.

30655 **Computer system for automatic inspection of fuel pellets.** Sternheim, E. (Westinghouse R and D Center, Pittsburgh, PA). *Trans. Am. Nucl. Soc.;* **33**: 917(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30656 **JUPITER: a design code for GCFR core thermal-hydraulics and pumping power analysis.** Majumdar, D. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.;* **33**: 949-951(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30657 **Methodology for statistical determination of fuel intra-assembly flow mixing uncertainty.** Tang, Y.S.; Friedland, A.J.; Markley, R.A. (Westinghouse Advanced Reactors Div., Madison, PA). *Trans. Am. Nucl. Soc.;* **33**: 951-953(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30658 **Prediction of coolant mixing peripheral flow in wire-wrapped rod bundles.** Wei, J.P. (General Electric Co., Sunnyvale, CA). *Trans. Am. Nucl. Soc.;* **33**: 953-955(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30659 **Stratification criteria in LMFBR outlet plena.** Carbajo, J.J. (Univ. of Illinois, Urbana). *Trans. Am. Nucl. Soc.;* **33**: 955-956(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30660 **Thermohydraulic performance of fast reactor fuel designed for low duct dilation.** Yang, J.W.; Fischer, G.J. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.;* **33**: 956-958(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30661 **STMFREQ: an advanced code for stability analysis of steam generators.** Chan, K.C.; Yadigaroglu, G. (Univ. of California, Berkeley). *Trans. Am. Nucl. Soc.;* **33**: 980-982(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30662 **Future plans for the design and construction of fast reactor power stations in the United States of America.** Squire, A. (Westinghouse Hanford Co., Richland, WA (USA)). pp 829-841 of Design, construction and operating experience of demonstration LMFBRs. Vienna, Austria; International Atomic Energy Agency (1978).

From Symposium on design, construction and operating experience of demonstration liquid metal fast breeder reactors; Bologna, Italy (10 Apr 1978).

The United States plans with fast breeder reactors are outlined. The basic elements are: (1) Completion and operation of the Fast Flux Test Facility (FFTF) as a fuels and materials test reactor, at the same time gaining experience in systems and component operation. (2) Completion of the CRBRP systems design. (3) Development of components for plants larger than CRBRP and tests of the CRBR pumps and steam generators. (4) Design studies on plants in the range of 650 MW(e) or larger. (5) Evaluation of core designs and fuel systems which utilize proliferation-resistant fuels. (6) Continuation of base technology effort in materials, safety, high temperature analysis, and associated areas, to assure availability of information if it is determined that the USA will proceed with deployment

of commercial breeder plants. In all this work, the FFTF is a cornerstone in that it provides a major testing capability to satisfy the diverse needs of the breeder reactor programme base technology development. The FFTF provides for irradiation testing of alternative fuel systems, as well as a site for testing plant systems and components.

REGULATION AND LICENSING

REFER ALSO TO CITATION(S) 30707

30663 (RDT-INDEX—(7-80)) **RDT Standards Index.** (Department of Energy, Washington, DC (USA). Office of Nuclear Energy Programs). Jul 1980. Contract W-7405-ENG-26. 39p. RSO free.

Attached is the July 1980 Index of RDT Standards. This issue covers April through June 1980. The attached New Publications List identifies each standard, amendment, and/or revision that was published during this period.

30664 (RDT-M—3-9T(5-80)(Rev.)) **Nickel-iron-chromium alloy seamless pipe and tubing (ASME SB-407 with additional requirements).** (Department of Energy, Washington, DC (USA). Office of Nuclear Energy Programs). May 1980. 8p. RSO.

This standard covers nickel-iron-chromium alloy seamless pipe and tubing for nuclear and associated applications. Material shall conform to the requirements of ASME SB-407; to the requirements of the ASME Boiler and Pressure Vessel Code (ASME Code), Section III, Article NB-2000; and to the additional requirements of this standard.

ECONOMICS

FUEL CYCLE

30665 (ORNL—5621) **ORIGEN2: a revised and updated version of the Oak Ridge isotope generation and depletion code.** Croff, A.G. (Oak Ridge National Lab., TN (USA)). Jul 1980. Contract W-7405-ENG-48. 62p. NTIS, PC A04/MF A01.

ORIGEN2 is a versatile point depletion and decay computer code for use in simulating nuclear fuel cycles and calculating the nuclide compositions of materials contained therein. This code represents a revision and update of the original ORIGEN computer code which has been distributed world-wide beginning in the early 1970s. The purpose of this report is to give a summary description of a revised and updated version of the original ORIGEN computer code, which has been designated ORIGEN2. A detailed description of the computer code ORIGEN2 is presented. The methods used by ORIGEN2 to solve the nuclear depletion and decay equations are included. Input information necessary to use ORIGEN2 that has not been documented in supporting reports is documented.

30666 (ORNL/TM—7175) **User's manual for the ORIGEN2 computer code.** Croff, A.G. (Oak Ridge National Lab., TN (USA)). Jul 1980. Contract W-7405-ENG-26. 196p. NTIS, PC A09/MF A01.

This report describes how to use a revised version of the ORIGEN computer code, designated ORIGEN2. Included are a description of the input data, input deck organization, and sample input and output. ORIGEN2 can be obtained from the Radiation Shielding Information Center at ORNL.

PROCESS HEAT REACTORS

REFER ALSO TO CITATION(S) 30714

30667 (GA-A—15868) **High-temperature process heat applications with an HTGR.** Quade, R.N.; Vrable, D.L. (General Atomic Co., San Diego, CA (USA)). Apr 1980. Contract AT03-76SF71061. 28p. (CONF-800578—1). NTIS, PC A03/MF A01.

From Conference on the utilization of small and medium size power reactors in Latin America; Montevideo, Uruguay (12 May 1980).

An 842-MW(t) HTGR-process heat (HTGR-PH) design and several synfuels and energy transport processes to which it could be coupled are described. As in other HTGR designs, the HTGR-PH has its entire primary coolant system contained in a prestressed concrete reactor vessel (PCRV) which provides the necessary biological shielding and pressure containment. The high-temperature nuclear thermal energy is transported to the externally located process plant by a secondary helium transport loop. With a capability to produce hot helium in the secondary loop at 800°C (1472°F) with current designs and 900°C (1652°F) with advanced designs, a large number of process heat applications are potentially available. Studies have been performed for coal liquefaction and gasification using nuclear heat.

30668 (GA-A—15875) **Design of the HTGR for process heat applications.** Vrable, D.L.; Quade, R.N. (General Atomic Co., San Diego, CA (USA)). May 1980. Contract AT03-76SF71061. 9p. (CONF-800806—9). NTIS, PC A02/MF A01.

From 15. intersociety energy conversion engineering conference; Seattle, WA, USA (18 Aug 1980).

This paper discusses a design study of an advanced 842-MW(t) HTGR with a reactor outlet temperature of 850°C (1562°F), coupled with a chemical process whose product is hydrogen (or a mixture of hydrogen and carbon monoxide) generated by steam reforming of a light hydrocarbon mixture. This paper discusses the plant layout and design for the major components of the primary and secondary heat transfer systems. Typical parametric system study results illustrate the capability of a computer code developed to model the plant performance and economics.

NUCLEAR REACTOR TECHNOLOGY

THEORY AND CALCULATION

REFER ALSO TO CITATION(S) 30653

30669 (ORNL/CSD/TM—127) **Generalized perturbation theory using two-dimensional, discrete ordinates transport theory.** Childs, R.L. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 119p. NTIS, PC A06/MF A01.

Perturbation theory for changes in linear and bilinear functionals of the forward and adjoint fluxes in a critical reactor has been implemented using two-dimensional discrete ordinates transport theory. The computer program DOT IV was modified to calculate the generalized functions Γ and Γ^*. Demonstration calculations were performed for changes in a reaction-rate ratio and a reactivity worth caused by system perturbations. The perturbation theory predictions agreed with direct calculations to within about 2%. A method has been developed for calculating higher λ eigenvalues and eigenfunctions using techniques similar to those developed for generalized functions. Demonstration calculations have been performed to obtain these eigenfunctions.

COMPONENTS AND ACCESSORIES

REFER ALSO TO CITATION(S) 30681, 30864, 30882, 31058

FUEL ELEMENTS

REFER ALSO TO CITATION(S) 30924, 31029, 31058, 31059

CONTROL SYSTEMS

30670 (GA-A—15738) **HTGR Gas Turbine Program. Semiannual progress report for the period ending September 30, 1979.** (General Atomic Co., San Diego, CA (USA)). May 1980. Contract AT03-76SF70046. 503p. NTIS, PC A22/MF A01.

Information on the HTGR-GT program is presented concerning systems design methods; systems dynamics methods; alternate design; miscellaneous controls and auxiliary systems; structural mechanics; shielding analysis; licensing; safety; availability; reactor turbine system integration with plant; PCRV liners, penetrations, and closures; PCRV structures; thermal barrier; reactor internals; turbomachinery; turbomachine remote maintenance; control valve; heat exchangers; plant protection system; and plant control system.

30671 (HEDL-SA—1987-FP) **Design of absorber assemblies with intentional pellet-cladding mechanical interaction.** Hollenberg, G.W.; Birney, K.R.; Pitner, A.L.; Basmajian, J.A. (Hanford Engineering Development Lab., Richland, WA (USA)). Apr 1980. Contract AC14-76FF02170. 27p. (CONF-800607—72). NTIS, PC A03/MF A01.

From American Nuclear Society annual meeting; Las Vegas, NV, USA (8 Jun 1980).

A number of improvements in absorber assembly performance characteristics can be achieved through implementation of absorber cladding mechanical interaction (ACMI). Benefits include lower operating temperatures, less potential for material relocation, longer lifetime, and increased reactivity worth. Analyses indicate that substantial cladding strains may be attainable without significant risk of breach. However, actual in-reactor testing of ACMI in

absorber elements will be required before design criteria can be revised to accept ACMI.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 30618

30672 (CONF-800573—1) **Socioeconomic impact assessment and nuclear power plant licensing, Greene County, New York.** Peelle, E. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 30p. NTIS, PC A03/MF A01.

From Conference on improving the scientific and technical information utilized in environmental impact statement; Rensselaerville, NY, USA (19 May 1980).

The paper reviews the setting, participants and status of the joint federal-state hearings, findings of the FES, problems of conducting social impact assessment (SIA) for the GCNPP, and the nature and effect of public participation in the formal, legalistic hearings process. The GCNPP is evaluated in terms of trends in Atomic Energy Commission-Nuclear Regulatory Commission social impact assessments from 1972 to 1979. Progress in the adequacy and relevance of social impact assessment is defined according to steps in a lengthy, evolutionary legitimation process.

30673 (ORNL/TM—7138) **Analysis of potential saltwater intrusion at NEP I and II power station.** Lee, D.W. (Oak Ridge National Lab., TN (USA)). Jun 1980. Contract W-7405-ENG-26. 36p. NTIS, PC A03/MF A01.

The potential of adverse environmental impacts to groundwater availability and groundwater quality from construction dewatering of the coastal aquifer at a proposed New England Power site was examined with an analytical model. The drawdown zone and the extent of saltwater intrusion were predicted with and without the use of a slurry-wall barrier. The use of a slurry wall to mitigate any adverse impacts is feasible but the limited understanding of the coastal aquifer demands that monitoring requirements be included in the construction plan.

RADIOACTIVE EFFLUENTS

REFER ALSO TO CITATION(S) 30286, 30626

30674 **Summary and discussion of findings from: population dose and health impact of the accident at the Three Mile Island Nuclear Station (a preliminary assessment for the period March 28-April 7, 1979).** Rockville, MD; Bureau of Radiological Health (1979). 7p. (NP—24440).

This report was prepared by technical staff members of the Nuclear Regulatory Commission (NRC), the Department of Health, Education and Welfare (HEW), and the Environmental Protection Agency (EPA), who constitute an Ad Hoc Population Dose Assessment Group. It is an assessment of the health impact on the approximately 2 million offsite residents within 50 miles of the Three Mile Island Nuclear Station from the dose received by the entire population (collective dose). The Ad Hoc Group has examined in detail the available data for the period up to and including April 7, 1979. The report also addresses several areas of concern about the types of radionuclides released, about the contribution to population exposure due to beta radiation (which does not penetrate the clothing and skin) emitted from the released radionuclides, about the degree of coverage afforded by available radiation measurements, and about the range of health effects that may result from the estimated collective dose.

CHEMICAL AND THERMAL EFFLUENTS

REFER ALSO TO CITATION(S) 31164

RESEARCH, TEST, AND EXPERIMENTAL REACTORS

REFER ALSO TO CITATION(S) 30334, 30703, 30704, 30705, 31058, 31094, 31103, 31316

30675 (CONF-800366—3) **Nuclear instrumentation system operating experience and nuclear instrument testing in the EBR-II.** Yingling, G.E.; Curran, R.N. (Argonne National Lab., IL (USA)). 1980. Contract W-31-109-ENG-38. 36p. NTIS, PC A03/MF A01.

From Specialists' meeting on LMFBR instrumentation and control; Tokyo, Japan (31 Mar 1980).

In March of 1972 three wide range nuclear channels were purchased from Gulf Atomics Corporation and installed in EBR-II as a test. The three channels were operated as a test until April 1975 when they became a permanent part of the reactor shutdown system. Also described are the activities involved in evaluating and qualifying neutron detectors for LMFBR applications. Included are descriptions of the ANL Components Technology Division Test Program and the EBR-II Nuclear Instrument Test Facilities (NITF) used for the in-reactor testing and a summary of program test results from EBR-II.

30676 (EGG-LO—87-80-135) **LOFT small break test thermocouple installation.** Fors, R.M. (EG and G Idaho, Inc., Idaho Falls (USA)). 28 May 1980. Contract AC07-76ID01570. 17p. (RE-A—80-044). NTIS, PC A02/MF A01.

The subject thermocouple design has been analyzed for maximum expected hydraulic loading and found to be adequate. The natural frequency of the thermocouple was found to be between the vortex shedding frequencies for the gas and liquid phase so that a tendency for resonance will exist. However, since the thermocouple support will have a restricted displacement, stresses found are below the endurance limit and, thus, are acceptable in respect to fatigue life as well as primary stress due to pressure loading.

30677 (EGG/LTR—141-109) **Modular drag disc turbine qualification tests.** Flitton, V.E. (EG and G Idaho, Inc., Idaho Falls (USA)). 6 Jun 1980. Contract AC07-76ID01570. 12p. NTIS, PC A02/MF A01.

Qualification Tests were performed on three modular drag-disc turbines (MDTT) at ARA III under the direction of C.E. Winsel. The tests were performed on MDTTs that had been rejected by the Quality Division (Quality Division Reports were issued) due to the sensitivity range and accepted as is by the Project Engineer. These tests consisted of full flow calibration and vibration tests. The results of these tests indicate the MDTT will survive 7.5g peak loading below 1400 Hz and should not be subjected to g loading for extended periods of time between 1400 and 1450 Hz.

30678 (EGG/LTR—141-118) **Feasibility transient test of a correlation type transit time flowmeter in the LTSF blowdown facility.** Baker, A.G. (Idaho National Engineering Lab., Idaho Falls (USA)). Feb 1980. Contract AC07-76ID01570. 102p. NTIS, PC A06/MF A01.

A feasibility test was made in September 1977 to determine the suitability of various transducer types as sensors for a cross-correlation type transit time flowmeter. The sensor types tested were single beam gamma densitometers, conductivity probes and passive thermocouples. Three forms of signal conditioning were applied to the thermocouple signals: bandpass amplification, frequency compensation and signal compression. The gamma densitometer was the most successful, the conductivity probe less successful and the thermocouple least successful. Further work is recommended.

30679 (EGG/LTR-LO—00-80-120) **Experimental data report for transient flow calibration facility tests IIB101, IIB102 and IIB201.** Wambach, J.L. (EG and G Idaho, Inc., Idaho Falls (USA)). 17 Jun 1980. Contract AC07-76ID01570. 97p. NTIS, PC A05/MF A01.

Thermal-hydraulic response data are presented for the transient performance tests of a pitot tube rake (IIB201) and a modular drag disc-turbine transducer (DTT) rake (IIB101, IIB102). The tests were conducted in a system which provided full scale simulation of the pressure vessel and broken loop hot leg piping of the Loss of Fluid Test Facility (LOFT). A load cell system was used to provide a reference mass flow rate measurement.

30680 (EGG/LTR-LO—87-80-134) **Stress analysis of the modified Pulsed Neutron Activation system downstream shield support structure.** Mosby, W.R. (EG and G Idaho, Inc., Idaho Falls (USA)). 28 May 1980. Contract AC07-76ID01570. 45p. (RE-A—80-047). NTIS, PC A03/MF A01.

The modified LOFT Pulsed Neutron Activation (PNA) System downstream shielding support structure was stress analyzed for deadweight and worst-case LOCE loads. No deficiencies were found in the structure. This stress analysis was performed for the PNA Shielding Configuration that has been used on Test L3-2 and that is to be used on Test L3-7.

30681 (EGG-SSDC—5088) **INEL test reactor facility alarms: descriptions, technical specifications, and modification procedure.** Potash, L.M.; Boone, M.P. (Idaho National Engineering Lab., Idaho Falls (USA)). Apr 1980. Contract AC07-76ID01570. 49p. NTIS, PC A03/MF A01.

This report identifies standards, procedures, and practices which will affect any attempt to integrate or introduce human engineering principles into nuclear power plant alarm systems. Additional information concerning type of signal used, expected reaction, type of sensor, etc., is presented because of its relevance to future work on alarm system integration. The INEL test reactors were studied. Interviews were conducted with operators, designers, and management personnel. Additional information was obtained from available documentation. Only fire-alarm systems, and to a lesser extent, criticality alarms, have detailed industry-wide standards. One general standard has been written for control-room annunciators.

30682 (HEDL-SA—2032-FP) **FFTF Heat Transport System (HTS) component and system design.** Young, M.W.; Edwards, P.A. (Hanford Engineering Development Lab., Richland, WA (USA)). 1980. Contract AC14-76FF02170. 6p. (CONF-800607—71). NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; Las Vegas, NV, USA (8 Jun 1980).

The FFTF Heat Transport Systems and Components designs have been completed and successfully tested at isothermal conditions up to 427°C (800°F). General performance has been as predicted in the design analyses. Operational flexibility and reliability have been outstanding throughout the test program. The components and systems have been demonstrated ready to support reactor powered operation testing planned later in 1980.

30683 (HEDL-SA—2133) **FFTF startup: status and results.** Noordhoff, B.H.; Moore, C.E. (Hanford Engineering Development Lab., Richland, WA (USA)). Mar 1980. Contract AC14-76FF02170. 39p. (CONF-800401—14). NTIS, PC A03/MF A01.

From 2. international conference of liquid metal technology for energy systems; Richland, WA, USA (20 Apr 1980).

Startup testing on the Fast Flux Test Facility (FFTF) during the past three years has progressed beyond initial criticality toward the principal goal of power demonstration in 1980. An overview is presented of technical results to date and project plans to achieve power demonstration and complete the startup test program.

30684 (JAPFNR—464) **Neutron and gamma ray streaming experiments at the fast neutron source reactor YAYOI. PNC-J—260-79-01-Tr.** Oka, Y.; Yanagisawa, I.; Akiyama, M.; An, S. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan); Tokyo Univ. (Japan). Faculty of Engineering). Jul 1979. 75p. NTIS (US Sales Only), PC A04/MF A01.

Work performed under United States-Japanese Fast Reactor Exchange Program.

Neutron and gamma ray streaming experiments were performed in the ducts and cavities that were located in the heavy concrete shields of the fast neutron source reactor YAYOI of University of Tokyo. The configurations have the feature that the streaming through the ducts are occurred following the scattering in the cavity. The axes of the ducts are perpendicular to the source radiation from the core. The spectrum of the source was modified by putting a plug in the beam hole of the core. An aluminum plug and the plug which contains paraffin were used. The decay in the ducts, however, hardly depends on the source spectrum. The decay in the ducts is nearly exponential.

30685 **Current status of the US RERTR Program.** Travelli, A. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **33**: 737-738(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30686 **Test bed for high-uranium-loaded fuel plates.** Senn, R.L.; Martin, M.M. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **33**: 739(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30687 **Generic study of research reactor fuel element loadings with reduced uranium enrichments.** Matos, J.E.; Freese, K.E. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **33**: 739-741(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30688 **Fourteen years of fuel management of the Penn State TRIGA Breazeale Reactor (PSBR).** Levine, S.H. (Pennsylvania State Univ., University Park); Totenbier, R.E.; Ali, A.T. *Trans. Am. Nucl. Soc.;* **33**: 741-742(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30689 **Uranium-zirconium hydride fuels development.** Gietzen, A.J. (General Atomic Co., San Diego, CA). *Trans. Am. Nucl. Soc.;* **33**: 742-743(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30690 **Development and irradiation perforance of uranium aluminide fuels in test reactors.** Beeston, J.M.; Gibson, G.W.; Newton, D.G.; Hobbins, R.R. (EG and G Idaho, Inc., Idaho Falls). *Trans. Am. Nucl. Soc.;* **33**: 744(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30691 **Upgrading the oxide fuel.** Copeland, G.L.; Knight, R.W.; Martin, M.M. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **33**: 744-745(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30692 **Development of a high-uranium-density fuel for research and test reactors.** Stahl, D.; Domagala, R.F.; Thresh, H.R. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **33**: 745(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30693 **Equilibrium code calculations for the Ford Nuclear Reactor with reduced enrichment fuel.** Komoriya, H. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **33**: 745-746(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30694 **Neutronic analysis of low-enrichment fuels for research reactors.** Brown, F.B.; Losey, D.C.; Wehe, D.K.; Lee, J.C.; Martin, W.R. (Univ. of Michigan, Ann Arbor). *Trans. Am. Nucl. Soc.;* **33**: 746-748(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30695 **Impact of reduced-enrichment fuel on research reactor performance and utilization.** Losey, D.C. (Univ of Michigan, Ann Arbor); Brown, F.B.; Martin, W.R.; Lee, J.C.; Komoriya, H. *Trans. Am. Nucl. Soc.;* **33**: 748-749(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30696 **Project update, Part II: the economic success of university-type reactors.** Bohannon, J.R. Jr.; Dunn, W.L.; Waver, J.; Miller, G.D. (North Carolina State Univ., Raleigh). *Trans. Am. Nucl. Soc.;* **33**: 773-774(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30697 **Gripper device for special handling of EBR-II reactor subassemblies.** Filewicz, E.C. (Argonne National Lab., IL); King, R.W. *Trans. Am. Nucl. Soc.;* **33**: 775-777(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30698 **Requalification of the LOFT reactor following a loss-of-coolant experiment (Level I).** Cannon, J.W. (EG and G Idaho, Inc., Idaho Falls). *Trans. Am. Nucl. Soc.;* **33**: 777(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30699 **Waterhammer phenomena in LOFT reactor secondary cooling system.** Hunter, J.A. (EG and G Idaho, Inc., Idaho Falls). *Trans. Am. Nucl. Soc.;* **33**: 777-778(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

PLUTONIUM AND ISOTOPE PRODUCTION REACTORS

30700 (UNI—1532) **TWFM trace analysis report.** Toffer, H.; Richardson, R.L.; Clayhold, J.A. (United Nuclear Industries, Inc., Richland, WA (USA)). 1 Jun 1980. Contract AC06-76RL01857. 39p. NTIS, PC A03/MF A01.

A Travelling Wire Flux Mapping (TWFM) system has been in operation at the N Reactor for over 15 years. Recently, the utility of the system as a true reactor surveillance and monitoring tool has been realized. A TWFM trace analysis program was put in place. In addition to calculating consistent axial peaking factors, the sophisticated computerized data analysis system permits detailed evaluation of the traces for flux perturbation caused by periodic and aperiodic reactor components. The system has the flexibility to directly record traces on magnetic tape and to digitize past TWFM trace data thereby generating a unique data base for reactor surveillance.

REACTOR SAFETY

30701 (CONF-800434—5) **Application of aerosol technology in LMFBR design.** Strawbridge, L.E.; Hemmerle, E.H. (Westinghouse Electric Corp., Madison, PA (USA). Advanced Reactors Div.). 1980. Contract AC15-76CL02395. 17p. NTIS, PC A02/MF A01.

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

Aerosol technology is applied in several areas in the safety assessment of liquid metal fast breeder reactors. This paper discusses the application of this technology in the assessment of the Clinch

River Breeder Reactor Plant. The importance of considering aerosol effects is discussed for sodium fires, the assessment of site suitability and the assessment of the consequences of accidents beyond the design base such as hypothetical core disruptive accidents. Areas in which further development work could have the most impact are indicated.

30702 (CONF-800607—58) **Determination of UO_2 electrical conductivity change when heated through melt.** Wright, A.L.; Kress, T.S.; Smith, A.M.; Rochelle, J.M. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 7p. NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; Las Vegas, NV, USA (8 Jun 1980).

Results are presented from experiments performed at ORNL in which qualitative measurements were made of the change in UO_2 electrical conductivity when heated through melt.

30703 (CONF-800723—18) **Fuel rod mechanical deformation during the PBF/LOFT lead rod loss-of-coolant experiments.** Varacalle, D.J. Jr.; MacDonald, P.E.; Shiozawa, S.; Driskell, W.E. (EG and G Idaho, Inc., Idaho Falls (USA)). 1980. Contract AC07-76ID01570. 33p. NTIS, PC A03/MF A01.

From 19. national heat transfer conference; Orlando, FL, USA (27 Jul 1980).

Results of four PBF/LOFT Lead Rod (LLR) sequential blowdown tests conducted in the Power Burst Facility (PBF) are presented. Each test employed four separately shrouded fuel rods. The primary objective of the test series was to evaluate the extent of mechanical deformation that would be expected to occur to low pressure (0.1 MPa), light water reactor design fuel rods when subjected to a series of double ended cold leg break loss-of-coolant accident (LOCA) tests, and to determine whether subjecting these deformed fuel rods to subsequent testing would result in rod failure. The extent of mechanical deformation (buckling, collapse, or waisting of the cladding) was evaluated by comparison of cladding temperature and system pressure measurements with out-of-pile experimental data, and by posttest visual examinations and cladding diametral measurements.

30704 (EGG-LOFT—5165) **Quick-look report on LOFT Nuclear Experiment L6-5.** Reeder, D.L. (Idaho National Engineering Lab., Idaho Falls (USA)). Jun 1980. Contract AC07-76ID01570. 40p. NTIS, PC A03/MF A01.

Experiment L6-5, the first experiment in the Loss-of-Fluid Test (LOFT) Anticipated Transient Experiment Series L6, was successfully completed on May 29, 1980. Experiment L6-5 simulated a complete loss of feedwater to all steam generators in a commercial pressurized water reactor with U-tube steam generators. After experiment initiation, the reactor was manually scrammed on an indication of low liquid level in the steam generator secondary side to simulate the automatic low-level trip on a commercial pressurized water reactor. Following scram, primary system pressure and pressurizer liquid level dropped rapidly, but after closure of the main steam control valve, they began to recover and were near their initial values by 200 s. As planned, after 200 s, the operators took manual control of the plant and returned both primary and secondary systems to hot-standby conditions within 1 hour.

30705 (EGG/LTR—1111-65(Rev.1)) **LOFT fuel bundle structural response to mechanical loads during subcooled LOCE.** Martinell, J.S. (EG and G Idaho, Inc., Idaho Falls (USA)). 2 Apr 1980. Contract AC07-76ID01570. 128p. (RE-A—79-120(Rev.1); USNRC-P—394). NTIS, PC A07/MF A01.

A structural analysis of the LOFT type A, D, and E fuel bundle assemblies was conducted to predict the response to combined axial and lateral loads experienced during the subcooled portion of a 5-in., 15-msec loss-of-coolant experiment (LOCE). The fuel bundle assemblies were modeled with a linear elastic finite element technique. Dynamic loads predicted in previous dynamic analyses were applied. Worst case misalignment of the upper and lower end boxes were assumed due to allowable tolerances within the flow skirt. This analysis yields maximum axial deflection, internal loads, and subsequent stress intensities in the fuel bundle structural components.

30706 (EPRI-NP—1353) **Study of pool-swell dynamics in a Mark II single-cell model. Final report.** Kiang, R.L.; Jeuck, P.R. III. (SRI International, Menlo Park, CA (USA)). Mar 1980. 140p. NTIS, PC A07/MF A01.

The dynamic response of a Mark II pressure-suppression system during the early air discharging phase of a postulated loss-of-coolant accident (LOCA) was studied via scale model experiments. Tests using a 13.3-scale single downcomer model yielded quantitative information on the vent-clearing process, the pool swell, the diaphragm floor differential pressure and many other dynamic responses of interest. Corresponding information for the reference plant from which the model is scaled can be obtained from the test results and the scaling laws which are given in the report. The single downcomer results were compared to multidowncomer results to determine the validity of single cell models. The comparison shows excellent agreement.

30707 (GA-A—15697) **Evaluation of proposed German safety criteria for high-temperature gas-cooled reactors.** Barsell, A.W. (General Atomic Co., San Diego, CA (USA)). May 1980. Contract AT03-76SF70046. 100p. NTIS, PC A05/MF A01.

This work reviews proposed safety criteria prepared by the German Bundesministerium des Innern (BMI) for future licensing of gas-cooled high-temperature reactor (HTR) concepts in the Federal Republic of Germany. Comparison is made with US General Design Criteria (GDCs) in 10CFR50 Appendix A and with German light water reactor (LWR) criteria. Implications for the HTR design relative to the US design and safety approach are indicated. Both inherent characteristics and design features of the steam cycle, gas turbine, and process heat concepts are taken into account as well as generic design options such as a pebble bed or prismatic core.

30708 (JAPFNR—466) **Activities in SBL-FPL loops for safety study of LMFBR(I). PNC-N—941-79-79.** (Power Reactor and Nuclear Fuel Development Corp., Oarai, Ibaraki (Japan). Oarai Engineering Center). Jun 1979. 22p. NTIS (US Sales Only), PC A02/MF A01.

Work performed under United States-Japanese Fast Reactor Exchange Program.

As the first step for the safety study of LMFBR, it is necessary to understand the initial events of possible accidents in LMFBR. Local faults and sodium boiling can be considered in that area. SBL and FPL were constructed to understand such phenomena experimentally. Two loops own jointly the dump tank and the purification loop. SIENA is the generic name to both loops. Test programs involving the test loops are described.

30709 (LA-UR—79-3279) **Two phase nonequilibrium heat transfer in the TRAC-PD2 code.** Mandell, D.A.; Liles, D.R. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 4p. (CONF-800723—13). NTIS, PC A02/MF A01.

From 19. national heat transfer conference; Orlando, FL, USA (27 Jul 1980).

TRAC is a best-estimate, multidimensional, nonequilibrium computer code intended for the analysis of loss-of-coolant accidents (LOCA's) in light water reactors. TRAC-PD2 is the third, detailed, pressurized water reactor version of the code. The TRAC code is modular both by components and by function. That is, vessels, pipes, pumps, etc. can be coupled together in any manner in order to simulate a reactor or a particular experimental facility. Individual physical phenomena are also coded in separate subroutines. This paper discusses the wall to fluid heat transfer coefficient correlations, the interfacial heat transfer models, and presents results for several experimental facilities.

30710 (LA-UR—80-1267) **Comparison of TRAC calculations with experimental data.** Jackson, J.F.; Vigil, J.C. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 25p. NTIS, PC A02/MF A01.

TRAC is an advanced best-estimate computer code for analyzing postulated accidents in light water reactors. This paper gives a brief description of the code followed by comparisons of TRAC calculations with data from a variety of separate-effects, system-effects, and integral experiments. Based on these comparisons, the capabilities and limitations of the early versions of TRAC are evaluated.

30711 (SAND—80-0334) **Nuclear power plant fire protection: philosophy and analysis.** Berry, D.L. (Sandia National Labs., Albuquerque, NM (USA)). May 1980. Contract AC04-76DP00789. 72p. NTIS, PC A04/MF A01.

This report combines a fire severity analysis technique with a fault tree methodology for assessing the importance to nuclear power plant safety of certain combinations of components and systems. Characteristics unique to fire, such as propagation induced by the failure of barriers, have been incorporated into the methodology. By applying the resulting fire analysis technique to actual conditions found in a representative nuclear power plant, it is found that some safety and nonsafety areas are both highly vulnerable to fire spread and impotant to overall safety, while other areas prove to be of marginal importance. Suggestions are made for further experimental and analytical work to supplement the fire analysis method.

30712 (SAND—80-0679(Pt.2)) **Identification of the impacts of maintenance and testing upon the safety of LWR power plants. Part II. Final report.** Husseiny, A.A.; Sabri, Z.A.; Turnage, J.J. (Science Applications, Inc., Ames, IA (USA)). Apr 1980. Contract AC04-76DP00789. 150p. (SAI—100-81-AM(Pt.2)). NTIS, PC A07/MF A01.

Information is presented concerning overview of literature relating to radiation exposure and operating experience; details of LWR-MTC3 classification system; histograms for individual BWR facilities depicting frequency of M and T mode and frequency of

systems and components involved with M and T problems; histograms for individual PWR facilities depicting frequency of M and T mode and frequency of systems and components involved with M and T problems; and Fortran program for M and T data clustering.

30713 (SAND—80-1574) **Light water reactor safety technology program. Quarterly report IV, January-March 1980.** Dahlgren, D.A. (Sandia National Labs., Albuquerque, NM (USA)). Jul 1980. Contract AC04-76DP00789. 68p. NTIS, PC A04/MF A01.

Information on PWR and BWR reactor safety is presented concerning the Technology Management Center support programs; risk method utilization; improved safety systems; man-machine interface; and safety data.

30714 **Reliable plant is a safe plant--lessons learned from TMI.** Ferguson, R.L. (US DOE, Washington, DC). *Proc., Annu. Reliab. Maintain. Symp.;* No. 80CH1513-IR), 76-78(1980).

From Reliability and maintainability symposium; San Francisco, CA, USA (22 Jan 1980).

Investigations, including that of the President's Commission on the Accident at Three Mile Island (the Kemeny Commission), have concluded that equipment failures initiated the accident at TMI and, that given these failures, appropriate operator actions during the early phases of the accident could have limited the consequences to those of a relatively insignificant incident. The equipment failures that initiated the accident were not unique. Many factors or shortcomings contributed to the actions of the operators. The unreliability of equipment and information display played a significant role in the TMI accident and contributed to the problems. There is evidence that this unreliability contributed greatly to developing a background of mistrust of system elements which, in turn, had conditioned the operators to misinterpret or dismiss important indications.

30715 (DOE-tr—156) **Heat transfer measurements in internally heated fluids in cylindrical convection cells.** Fieg, G. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik). Aug 1979. Translation of KFK—2712, October 1978. 29p. NTIS (US Sales Only), PC A03/MF A01.

Work performed under United States-W. Germany Fast Reactor Exchange Program.

Model experiments have been performed to study the stationary, natural convection heat transfer of internally heated fluids in cylindrical convection cells. The influence of geometry (aspect ratio) as well as of different thermal wall conditions on to the heat transport characteristics have been investigated. The aim of these model experiments is the verification of thermohydraulic codes for PAHR studies; therefore, the temperature and velocity fields in the convecting fluids have also been measured. The results of these experiments are compared, as far as possible, with existing thermohydraulic codes and simpler model assumptions like the zone-model of Baker et al. These theoretical models can, after experimental verification, be used to study realistic PAHR situations.

30716 **Convective heat transfer coefficient enhancement in two-phase nonboiling flow.** Chu, Y.C.; Jones, B.G. (Univ. of Illinois, Urbana). *Trans. Am. Nucl. Soc.;* **33**: 960-961(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30717 **Modeling film boiling destablization due to a pressure shock arrival.** Corradini, M.L. (Sandia Labs., Albuquerque, NM). *Trans. Am. Nucl. Soc.;* **33**: 961-962(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30718 **Influence of rapid decompression on boiling transition.** Kung, S.P.; Lester, T.W. (Kansas State Univ., Manhattan). *Trans. Am. Nucl. Soc.;* **33**: 962-963(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30719 **Prediction of CHF in rod bundles using round-tube CHF correlation.** Leung, J.C.M.; Henry, R.E. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **33**: 963-966(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30720 **New formulation for inverted annular film boiling heat transfer.** Chan, K.C.; Yadigaroglu, G. (Univ. of California, Berkeley). *Trans. Am. Nucl. Soc.;* **33**: 966-967(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30721 **CHF in fuel bundles at low mass velocities.** Atkinson, S.A. (EG and G Idaho, Inc., Idaho Falls, ID); Gottula, R.C.; Eide, S.A. *Trans. Am. Nucl. Soc.;* **33**: 967-969(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30722 **General transient analysis of steam chugging.** Pitts, J.H. (Univ. of California, Livermore). *Trans. Am. Nucl. Soc.;* **33**: 972-973(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30723 **Effect of heater rod dynamics on CCFL mechanisms.** Lahey, R.T. Jr.; Ohkawa, K. (Rensselaer Polytechnic Inst., Troy, NY). *Trans. Am. Nucl. Soc.;* **33**: 976-978(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30724 **Dynamic analysis of a drag-disk in transient two-phase flow.** Kamath, P.S.; Lahey, R.T. Jr. (Resselaer Polytechnic Inst., Troy, NY). *Trans. Am. Nucl. Soc.;* **33**: 978-980(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30725 **Determination of mass exchange rates in ^{16}N-tagged slug flow.** Perez-Griffo, M.L.; Block, R.C.; Lahey, R.T. Jr. (Rensellaer Polytechnic Inst., Troy, NY). *Trans. Am. Nucl. Soc.;* **33**: 984-986(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

ENERGY STORAGE

MAGNETIC

REFER ALSO TO CITATION(S) 30600

COMPRESSED GAS

30726 (DOE/ET/29245—1) **Cavity degradation risk insurance assessment. Final report.** Hampson, C.; Neill, P.; de Bivort, L. (International Research and Technology Corp., McLean, VA (USA)). 1980. Contract AC02-78ET29245. 298p. NTIS, PC A13/MF A01.

This study examined the risks and risk management issues involved with the implementation by electric power utilities of compressed air energy storage and underground pumped hydro storage systems. The results are listed in terms of relative risks for the construction and operation of these systems in different geologic deposits, with varying amounts of pressurization, with natural or man-made disasters in the vicinity of the storage equipment, and with different modes of operating the facilities. (LCL)

PUMPED HYDRO

REFER ALSO TO CITATION(S) 30726

FLYWHEELS

30727 **Plant for generating and accumulating electric energy with the aid of wind power or solar energy.** Theyse, F.H. (to Stichting Energieonderzoek Centrum Nederland). US Patent 4,171,491. 16 Oct 1979. Priority date 18 Dec 1975, Netherlands, 4p.

An electric solar or wind power plant with a flywheel battery in which the electric generator is in the form of a dc generator is described. The generator is electrically connected to brushless dc motors switched in parallel, which can also act as generators and each of which is coupled to a flywheel.

THERMAL

REFER ALSO TO CITATION(S) 30541, 30542

30728 (NRL-MR—4267) **Energy storage as heat-of-fusion in containerized salts: report on energy storage boiler tank.** Chubb, T.A.; Nemecek, J.J.; Simmons, D.E. (Naval Research Lab., Washington, DC (USA)). 27 Jun 1980. Contract AI01-76ET20191. 110p. NTIS, PC A06/MF A01.

Energy storage based on heat-of-fusion in containerized salt is discussed. The energy storage boiler tank uses evaporation and condensation of a heat transfer fluid to provide heat transfer into and out of stacked cans of salt. The energy storage superheater tank uses a network of alkali metal heat pipes to distribute heat throughout a building filled with salt cans. It uses radiation to transfer energy to

and from stacked cans of salt. The rationale for energy storage in containerized salt, salt selection, salt availability, salt processing, container requirements, can technology and heat transfer fluid degradation problems are discussed. These discussions lead to estimates of energy storage system costs. The Naval Research Laboratory is building a 2 MWht proof-of-concept energy storage boiler tank. Laboratory investigations studying the compatibility of the heat transfer fluid with the molten storage salt are described, along with measurements of temperature drops associated with the energy input process. An assessment of the current status of the energy storage boiler tank is presented.

30729 (ORNL/Sub—7585/1) **Life and stability testing of packaged low-cost energy storage materials.** Frysinger, G.R. (Delaware Univ., Newark (USA). Inst. of Energy Conversion). Jul 1980. Contract W-7405-ENG-26. 120p. NTIS, PC A06/MF A01.

A low-cost laminated plastic film which is used to contain a Glauber's salt-based phase change thermal energy storage material in sausage-like containers called Chubs is discussed. The results of tests performed on the Chub packages themselves and on the thermal energy storage capacity of the packaged phase change material are described. From the test results, a set of specifications have been drawn up for a film material which will satisfactorily contain the phase change material under anticipated operating conditions. Calorimetric testing of the phase change material with thermal cycling indicates that a design capacity of 45 to 50 Btu/lb for a ΔT of 30°F can be used for the packaged material.

30730 (PNL—3298) **Descriptive analysis of aquifer thermal energy storage systems.** Reilly, R.W. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jun 1980. Contract AC06-76RL01830. 83p. NTIS, PC A05/MF A01.

The technical and economic feasibility of large-scale aquifer thermal energy storage (ATES) was examined. A key to ATESs attractiveness is its simplicity of design and construction. The storage device consists of two ordinary water wells drilled into an aquifer, connected at the surface by piping and a heat exchanger. During the storage cycle water is pumped out of the aquifer, through the heat exchanger to absorb thermal energy, and then back down into the aquifer through the second well. The thermal storage remains in the aquifer storage bubble until required for use, when it is recovered by reversing the storage operation. For many applications the installation can probably be designed and constructed using existing site-specific information and modern well-drilling techniques. The potential for cost-effective implementation of ATES was investigated in the Twin Cities District Heating-Cogeneration Study in Minnesota. In the study, ATES demonstrated a net energy saving of 32% over the nonstorage scenario, with an annual energy cost saving of $31 million. Discounting these savings over the life of the project, the authors found that the break-even capital cost for ATES construction was $76/kW thermal, far above the estimated ATES development cost of $23 to 50/kW thermal. It appears tht ATES can be highly cost effective as well as achieve substantial fuel savings. ATES would be environmentally beneficial and could be used in many parts of the USA. The existing body of information on ATES indicates that it is a cost-effective, fuel-conserving technique for providing thermal energy for residential, commercial, and industrial users. The negative aspects are minor and highly site-specific, and do not seem to pose a threat to widespread commercialization. With a suitable institutional framework, ATES promises to supply a substantial portion of the nation's future energy needs. (LCL)

BATTERIES

30731 **Evidence for reductive quenching of singlet excited methylene blue by iron(II).** Osif, T.L.; Lichtin, N.N.; Hoffman, M.Z.; Ray, S. Contract EY-76-S-02-2889. *J. Phys. Chem.;* **84**: No. 4, 410-414(21 Feb 1980).

Quenching of singlet excited methylene blue by Fe/sup II/$(H_2O)_5^{2+}$ and Fe/sup II/$(H_2O)_5Cl^+$ has been investigated in 0.01 M solutions of HCL in water and in 50 v/v % aqueous CH_3CN by laser flash photolysis-kinetic spectrometry by use of a Q-switched ruby laser emitting at 694.3 nm and time resolutions to 100 ns. Semimethylene blue quenching was monitored at 370 and 840 nm. It has been shown that in 50 v/v % aqueous CH_3CN direct reduction is an important pathway in the quenching of singlet methylene blue. A similar conclusion is consistent with data obtained in aqueous solution.

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 30407, 30838, 30841, 31116, 31117, 31118, 31119

30732 (ANL—79-94) **High-performance batteries for electric-vehicle propulsion and stationary energy storage. Progress report, October 1978-September 1979.** (Argonne National Lab., IL (USA)). Mar 1980. Contract W-31-109-ENG-38. 258p. NTIS, PC A12/MF A01.

The research, development, and management activities of the programs at Argonne National Laboratory (ANL) and at contractors' laboratories on high-temperature batteries during the period October 1978 to September 1979 are reported. These batteries are being developed for electric-vehicle propulsion and for stationary energy-storage applications. The present cells, which operate at 400 to 500°C, are of a vertically oriented, prismatic design with one or more inner positive electrodes of FeS or FeS_2, facing negative electrodes of lithium-aluminum or lithium-silicon alloy, and molten LiCl-KC1 electrolyte. During this reporting period, cell and battery development work has continued at ANL and contractors' laboratories. A 40 kWh electric-vehicle battery (designated Mark IA) was fabricated and delivered to ANL for testing. During the initial heat-up, one of the two modules failed due to a short circuit. A failure analysis was conducted, and the Mark IA program completed. Development work on the next electric-vehicle battery (Mark II) was initiated at Eagle-Picher Industries, Inc. and Gould, Inc. Work on stationary energy-storage batteries during this period has consisted primarily of conceptual design studies. 107 figures, 67 tables.

30733 (CONF-800324—4) **Development of high temperature secondary Li-Al/FeS/sub x/ batteries at Argonne National Laboratory.** Battles, J.E.; Gay, E.C.; Steunenberg, R.K.; Barney, D.L. (Argonne National Lab., IL (USA)). 1980. Contract W-31-109-ENG-38. 50p. NTIS, PC A03/MF A01.

From Seminar on electrochemical systems: batteries and fuel cells; Fortaleza-Ceara, Brazil (2 Mar 1980).

A general introduction to the battery program is given first. Subsequent sections discuss cell development, results of cell testing, and materials and component development - electrical feedthrough, electrode separators, materials for current collectors, and post-test cell examination (cell failure mechanisms, copper deposition in electrode separators, lithium gradient in negative electrodes). The Mark IA battery developed a short circuit in one of the modules that resulted in complete failure of the module; the other module was unaffected. 10 tables. (RWR)

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 31116, 31120, 31122, 31138, 31224, 31238

30734 (LMSC-D—683375) **Reactive metal-air batteries for automotive propulsion. Final report, August 1, 1978-November 30, 1979.** Momyer, W.R.; Morris, J.L. (Lockheed Missiles and Space Co., Palo Alto, CA (USA). Lockheed Palo Alto Research Lab.). 20 Dec 1979. Contract ET-78-C-03-1872. 174p. NTIS, PC A08/MF A01.

Lithium-water-air (Li-H_2O-air) cells with electrode areas of 500 cm^2 were discharged in an acrylic cell casing designed specifically for this purpose. Numerous cells were discharged in lithium hydroxide (LiOH) electrolyte at an electrolyte temperature near 25°C. Power output was regulated by controlling the LiOH concentration in the electrolyte. The cells were normally discharged at voltages from 2.0 to 2.3 V and current densities ranging from 50 to 200 mA/cm^2. The design power density of 0.4 W/cm^2 was achieved at Li current efficiencies near 90 percent by the conclusion of the test program. The Li-H_2O-air electrochemical couple does not appear to exhibit any significant scaling factor in regard to either electrode area or the number of cells in the battery. A detailed investigation was carried out to determine the applicability of the aluminum-water-air (Al-H_2O-air) cell concept as a power source for automotive propulsion. The characteristics of various candidate Al alloys were determined in both laboratory half-cell corrosion studies and full-cell discharge studies. Examination of the effect of variations in operational parameters of a subscale 50-cm^2 cell was accomplished, and the critical parameters were identified. Evaluation of candidate air cathodes from several sources was undertaken. Cathodes from only two sources were found to have adequate polarization characteristics; of these, only one possessed the durability desired for automotive applications. For a full cell, peak power density of 378 mW/cm^2 at 425 mA/cm^2 was obtained. At a nominal useful voltage of 1.3 V, the power density was 230 mW/cm^2 at 175 mA/cm^2. Coulombic efficiencies of 90 percent were obtained. 48 figures, 9 tables.

30735 (SAND—79-2148) **Performance data for a lithium-silicon/iron disulfide, long-life, primary thermal battery.** Quinn, R.K.; Baldwin, A.R.; Armijo, J.R. (Sandia National Labs., Albuquerque, NM (USA)). Jun 1980. Contract AC04-76DP00789. 19p. NTIS, PC A02/MF A01.

A 60-minute, 28-volt, 0.5-ampere, primary thermal battery with a volume of 400 cm^3 was developed in the Li(Si)/LiCl-KCl/FeS_2 electrochemical system. The effects of various simulated environmental tests on the performance of this battery are described. 8 figures, 1 table.

30736 (SAND—79-2155) **Electrochemical and surface analysis of the reactive interfaces in the Li(Si)/FeS_2 primary battery.** Quinn, R.K.; Zurawski, D.E.; Armstrong, N.R. (Sandia National Labs., Albuquerque, NM (USA); Arizona Univ., Tucson (USA). Dept. of Chemistry). Jul 1980. Contract AC04-76DP00789. 28p. NTIS, PC A03/MF A01.

Compositional changes in the anode, electrolyte, and cathode regions of the Li(Si)/LiCl-KCl/FeS_2 battery system were studied. The results of studies by scanning electron and photomicroscopy, electron microprobe analysis, and Auger electron spectroscopy of the anode/electrolyte-binder interface and the cathode/electrolyte-binder interface are presented. Analyses of single-cell discharges, where current density, temperature, and time can be controlled, show significant migration of sulfur, iron, and silicon. This migration apparently results in a concentration of sulfur and iron in a well-defined, narrow region approximately in the center of the electrolyte. A mechanism for this observation is proposed. 8 figures, 3 tables.

30737 (SAND—79-2155C) **Electrochemical and surface analysis of the reactive interfaces in the Li(Si)/FeS_2 primary battery.** Quinn, R.K.; Zurawski, D.E.; Armstrong, N.R. (Sandia National Labs., Albuquerque, NM (USA); Arizona Univ., Tucson (USA). Dept. of Chemistry). 1980. Contract AC04-76DP00789. 31p. (CONF-800917—3). NTIS, PC A03/MF A01.

From 12. power sources conference; Brighton, UK (15 Sep 1980).

Portions of document are illegible.

Compositional changes in the anode, electrolyte, and cathode regions of the Li(Si)/LiCl-KCl/FeS_2 battery system were studied. The results of studies by scanning electron and photomicroscopy, electron microprobe analysis, and Auger electron spectroscopy of the anode/electrolyte-binder interface and the cathode/electrolyte-binder interface are presented. Analyses of single-cell discharges, where current density, temperature, and time can be controlled, showed significant migration of sulfur, iron, and silicon. This migration apparently results in a concentration of sulfur and iron in a well-defined, narrow region approximately in the center of the electrolyte. A mechanism for this observation is proposed. 8 figures, 3 tables.

30738 (SAND—80-0423) **Aging study of Li(Si)/FeS_2 thermally activated batteries.** Searcy, J.Q.; Neiswander, P.A. (Sandia National Labs., Albuquerque, NM (USA)). May 1980. Contract AC04-76DP00789. 25p. NTIS, PC A02/MF A01.

A technique for accelerating the aging process of thermally activated batteries that use iron disulfide was developed. In this approach, storage at 130°C for one week was assumed equivalent to a shelf life of five years. Some of the batteries stored at 130°C were discharged to test for functionality changes, and others were disassembled and carefully analyzed for evidence of deleterious reactions. Some functionality anomalies were observed. The only deleterious reaction observed was that of Li(Si) reacting with water vapor. 3 figures, 6 tables.

30739 (UCRL—15242) **Preliminary energy use and economic analysis of the aluminum-air battery for automotive propulsion.** Hudson, C.L.; Putnam, E.S. (Interplan Corp., Santa Barbara, CA (USA)). Apr 1980. Contract W-7405-ENG-48. 45p. NTIS, PC A03/MF A01.

The first attempt to conduct an overall analysis of the potential capital and life-cycle costs and energy efficiency of a passenger vehicle powered by an aluminum-air battery is presented. Hydrated alumina is the principal reaction product. Estimates of the operating characteristics of the vehicle were made on the basis of laboratory test results, performance-simulation-model test results, and hypotheses on the refueling. The LLL performance simulation model provided input data to the analysis on component weights, total vehicle weight, and fuel efficiency by simulating the SAE 227a(D) driving cycle for a five-passenger vehicle with an assumed power-to-weight ratio of 50 W/kg (0.03 hp/lb) and a range of 1600 km. The results indicated that the total vehicle weight would be 1854 kg, including a passenger and cargo load of 136 kg, and that the vehicular fuel efficiency would be 51 g/km. Cost and energy parameters were estimated on the basis of existing technology and resource pricing structures. Then the results of theses status-quo assessments were considered in the light of potential changes in technology and resource prices. The net cost to the consumer for aset of recycled replacement anodes was found to be $90 to $100. At the predicted fuel efficiency, the inferred fuel-related operating costs would be about 6 cents/km. The initial vehicle cost is estimated at $6650 and the life-cycle cost at 18 cents/ km. The aluminum-air-battery vehicle was found to be a serious contender for future transportation markets. 3 figures, 14 tables.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 30837, 30966

30740 (CONS—5161-T1) **Low-cost fabrication of thin-walled solid electrolyte tubes from doctor-bladed ceramic tape.** Dirstine, R.T. (Globe-Union, Inc., Milwaukee, WI (USA). Corporate Applied Research Group). 1979. Contract EM-78-C-01-5161. 76p. NTIS, PC A05/MF A01.

Sodium β-Al_2O_3 tubes having wall thicknesses of typically 0.4 mm were fabricated from doctor-bladed (cast) ceramic tape by use of proprietary organic slip compositions and zeta-processed, lithia-stabilized alumina power. The ceramic tubes fabricated from cast tape had low porosity, low resistivity (~ 4 ohm-cm at 300°C), and good mechanical strength. Alternative fabrication techniques for manufacture of tubes from tape were evaluated, and the primary processing requirements/obstacls were identified. Closed-end tubes, nominally 10 mm outer diameter, 60 mm in length, and with a wall thickness of 0.3 mm, were supplied to the Department of Energy. 26 figures, 10 tables.

30741 (COO—4451-3) **Electrolytic degradation of lithia-stabilized β''-alumina. Technical progress report, April 1, 1979-June 30, 1980.** Virkar, A.V. (Utah Univ., Salt Lake City (USA). Dept. of Materials Science and Engineering). Jul 1980. Contract AS02-77ER04451. 49p. (UTEC—80-100). NTIS, PC A03/MF A01.

Research activities during the period April 1, 1979 to June 30, 1980 are described in the following areas: theoretical development of the model-solution to the Laplace equation for determining the flux of sodium ions to the sodium-filled cracks; determination of crack propagation rates via low-temperature degradation of bar specimens; design and construction of apparatus for wetting studies on β''-alumina and NASICON; calculation of current concentration near nonwetted areas by the method of Papamichael and Whiteman; testing of effects of bakeout and additives on sodium-sodium cells and design of disc cells; fabrication and testing of NASICON solid electrolyte. Important findings during the present year are as follows: high-temperature bakeout is essential to ensure complete wetting - improved wetting significantly improves performance of cells; ion focusing to a sodium-filled crack is determined by solution of the Laplace equation for appropriate boundary conditions; crack propagation rates are determined by strength measurements after electrolysis; current concentration near nonwetted areas is calculated by the conformal transformation technique of Papamichael and Whiteman. 14 figures, 1 table.

30742 (GEPP-OP—497) **Characterization studies and defect analysis of thermal battery components.** Antepenko, R.J. (General Electric Co., St. Petersburg, FL (USA). Neutron Devices Dept.). 1980. Contract AC04-76DP00656. 11p. (CONF-800538—2). NTIS, PC A02/MF A01.

From ACS meeting-in-miniature; Tampa, FL, USA (8 May 1980).

A very brief discussion on thermal batteries and the analytical techniques and procedures used in obtaining data characterizing the various battery components is given. The information is taken from four publications: GEPP-189, GEPP-299, GEPP-260, and GEPP-TM-459. 4 figures. (RWR)

30743 (SAND—80-0269C) **Solutions for resistance-after-fire problems in an electric match.** Heckes, A.A.; Montoya, A.P. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 15p. (CONF-800713—13). NTIS, PC A02/MF A01.

From 7. international pyrotechnics seminar; Vail, CO, USA (14 Jul 1980).

Current leakage in an electric match after firing is a problem if it drains power that can be used elsewhere or if it induces unwanted fluctuations in other electrical circuits. Two novel techniques are described that significantly reduce the RAF sensitivity of a Ti/$KClO_4$-loaded electric match used to ignite the pyrotechnic materials in a thermal battery. In the first technique, a thin (less than 10 μm thick) film insulator, such as Parylene or SiO_2, is vapor deposited within the match cavity prior to the loading of the pyrotechnic. The insulator tends to smooth the cavity surface as an aid to ejection of firing residues and to decrease the exposed metal surface area to prevent pin-to-pin short circuits. The second technique involves placing a length of heat-shrinkable tubing on the match extending from the output end so that the shrink tubing is activated by the heat of the match and the thermal battery when fired. The shrinkage of the tubing effectively decreases the cross-sectional area for mass and heat transfer from the battery back into the match. 5 figures, 2 tables.

30744 **Treatment of electrochemical cell components with lithium tetrachloroaluminate (LiAlCl/sub 4/) to promote electrolyte wetting.** Eberhart, J.G.; Battles, J.E. (to Dept. of Energy). US Patent 4,189,827. 26 Feb 1980. Filed date 3 Nov 1978. 6p.

PAT-APPL-957,619.

Electrochemical cell components such as interelectrode separators, retaining screens, and current collectors are contacted with lithium tetrachloroaluminate prior to contact with molten electrolytic salt to improve electrolyte wetting. The $LiAlCl_4$ can be applied in powdered, molten, or solution form; but, since this material has a

lower melting point than the electrolytic salt used in high-temperature cells, the powdered $LiAlCl_4$ forms a molten flux prior to contact by the molten electrolyte when both materials are initially provided in solid form. Components of materials such as boron nitride and other materials that are difficult to wet with molten salts are advantageously treated by this process.

APPLICATIONS

REFER ALSO TO CITATION(S) 30739

ENERGY MANAGEMENT AND POLICY

ENERGY MANAGEMENT AND POLICY

REFER ALSO TO CITATION(S) 31447

30745 Workshop on energy data of developing countries. Volume II. Basic energy statistics and energy balances of developing countries, 1967 to 1977. Paris, France; Organisation for Economic Co-Operation and Development (1979). 546p. (CONF-781272—(Vol.2)). $15.00.

From Workshop on energy data of developing countries; Paris, France (11 Dec 1978).

Extensive data on energy sources and balances are presented for Algeria, Argentina, Brazil, Colombia, Egypt, India, Indonesia, Iran, Jamaica, Kenya, Republic of Korea, Mexico, Nigeria, Saudi Arabia, Thailand, and Venezuela. Domestic consumption, final consumption, and energy end uses by the various sectors of consumer transactions are indicated. Data are compiled on imports and exports, production, and flows of fuels (processes to provide another energy commodity).

ENERGY ANALYSIS AND MODELING

REFER ALSO TO CITATION(S) 30774, 30775, 30809

30746 (EUR—6758-EN) Application of different KFA models in the framework of the energy research program of the European Communities. Final report. (Commission of the European Communities, Luxembourg). 1980. 98p. NTIS (US Sales Only), PC A05/MF A01.

The EC research program is implemented by means of so-called indirect actions, i.e., by concluding research contracts, on a cost-sharing basis, between the Commission of the European Communities and research laboratories, industrial firms, universities, or other third parties in the Member Countries. This report results from a contract of the sub-program on systems analysis/energy modelling and contains sections devoted to the following: (1) an energy policy to decrease the dependency on oil and gas imports in the Federal Republic of Germany; (2) the FRLWFB (Fuel Requirement LWR/FBR) and FRHT (Fuel Requirement HTR) nuclear mass balance programs; (3) investments in environmental protection in the energy sector: their effects on the gross domestic product; and (4) a data model interface for modular dynamic simulation.

30747 Methods and analysis of study projections. pp 529-611 of Energy in transition 1985-2010. Brooks, H.; Ginzton, E.L. (eds.). San Francisco, CA; W.H. Freeman and Co. (1980).

CONAES asked several of its panels to develop models of energy and the economy to make plain the interrelations among variables influencing energy supply and demand. One of the puzzles emerging is the difference in shape of the curves projecting energy consumption over the next three decades. Those of the Demand and Conservation Panel (reflected in the curves of the study scenarios) show a considerable degree of saturation. They rise rapidly in the early part of the period 1975-2000 and level off late in the period. The curves of the Modeling Resource Group tend to be more nearly uniform over the same period. The Demand and Conservation Panel's results were computed from a model based on prices of net delivered energy, while those of the Modeling Resource Group were computed on the basis of the price elasticity of demand for primary energy. It is difficult to make a confident choice between the price elasticities of the two models particularly as to which yields more realistic results. It is important to note a factor that could make the lower-energy-growth scenarios easier to achieve than implied here. The energy conservation shown in all the scenarios is achievable by the application of known technology or of technological principles that have already been demonstrated. It does not incorporate contributions to energy efficiency from major technological innovation. Given a favorable political and economic climate for innovations in energy efficiency, substantial opportunities exist to develop and market ingenious new energy-conserving technologies.

30748 Workshop on energy data of developing countries. Volume I. Summary of discussions and technical papers. Paris, France; Organisation for Economic Co-Operation and Development (1979). 128p. (CONF-781272—(Vol.1)). $10.00.

From Workshop on energy data of developing countries; Paris, France (11 Dec 1978).

The main objective of the workshop was to improve understanding regarding the collection, reporting, and interpretation of energy data of developing countries, thus providing a better basis for data compilation, forecasts and policy analysis. Experts from ten developing countries in Africa, Asia, and Latin America attended. Experts were also present from the United Nations and certain regional and specialized agencies (ESCAP, IAEA), the Commonwealth Science Council, the World Bank, the Latin American Energy Organisation (OLADE), the Commission of the European Communities, Instituto de Economia Energetica Asociado a Fundacion Bariloche (Buenos Aires), the Institute of Energy Economics (Tokyo), Resources for the Future (Washington, DC), and the Energy Research Group, Cambridge University (UK). Experts from several IEA countries and France also attended. Major topics discussed included the definition, collection, analysis, and presentation of national and international energy statistics; the integration of fuel-supply and sector end-use data into internally and internationally consistent energy balances; national and international approaches to energy forecasting and modelling techniques; and future cooperation in the field of energy statistics. Panel discussions on non-commercial fuels and on individual energy commodity balances rounded out the workshop. An accompanying volume, Vol. II, Basic Energy Statistics and Energy Balances of Developing Countries, presents detailed energy statistics and balances for certain developing countries for the period 1967-1977.

ECONOMICS AND SOCIOLOGY

REFER ALSO TO CITATION(S) 30201, 30763, 30764, 30765, 30767, 30768, 30778

30749 Quality of life: an international comparison. Hopkinson, J.; Anderson, C.F.; Liu, B.C. *EPRI J.;* 26-31(Apr 1980).

Dissatisfaction with gross national product (GNP) as a realistic yardstick for comparing the well-being of societies has led to a quality of life (QOL) concept which considers the environment in which people live. QOL includes both the economic and noneconomic factors affecting an individual's happiness. An international comparison of energy, GNP, and QOL in 50 countries considers five major categories (social, economic, health and education, environmental, and national vitality and security) and 12 subcategories. The study indicates that substantial increases in energy consumption will be needed to raise the living standards of developing countries. QOL appears to decline beyond a certain level of GNP, while continuing a direct relationship to per capita energy consumption and electricity production. 12 references. (DCK)

30750 Direct and indirect economic impacts of a National Energy Plan scenario. Sathaye, J.; Ruderman, H. (Lawrence Berkeley Lab., CA). *Energy Syst. Policy;* 3: No. 4, 309-336(1980).

This study estimates both the direct and indirect, or secondary, economic impacts of the development of future energy supplies in the United States. Direct impacts include capital investment and manpower requirements for construction of new energy supply facilities. Indirect impacts include the secondary value added (income) and employment stimulated by construction of energy facilities. These impacts are estimated for the United States until the year 1990 for an energy supply scenario based on the National Energy Plan. The results indicate that investment requirements for even a modest level of solar heating might dominate the future energy investment. Solar heating might also require a growth in manpower skills far in excess of historically observed growth rates. It is unlikely, however, that either direct or indirect requirements would pose a constraint to energy development on a national level. 7 references, 9 tables.

ENVIRONMENT, HEALTH, AND SAFETY

REFER ALSO TO CITATION(S) 30746, 31115, 31130, 31149

30751 Summary of the seventh government affairs seminar: the Clean Air Act - what's happening. Beery, W.T. (ed.). Pittsburgh, PA; Air Pollution Control Association (1979). 74p. (NP—24460).

This seminar, sponsored by the Air Pollution Control Association with the cooperation of the APCA Government Affairs Committee was held in Washington, DC on March 21-22, 1979. The contents of this summary were taken from a transcription of the taped proceedings. The program featured sessions on the effect of the 1977 Clean Air Act Amendments on energy and economics, on mobile sources, on new sources, and on the State Implementation Plans. After formal presentations, panel members answered questions from the audience. This discussion material is included in this summary of the seminar.

30752 Risks of energy systems. pp 422-499 of Energy in transition 1985-2010. Brooks, H.; Ginzton, E.L. (eds.). San Francisco, CA; W.H. Freeman and Co. (1980).

The health and environmental risks of energy systems are just some of many concerns that must be balanced in formulating energy policy. Furthermore, many aspects of these concerns are new: our knowledge of several important risks, as well as our knowledge of how to control them, is recent and incomplete. Energy policy must be formulated with the knowledge available. Even were such knowledge greater than it is today, difficult decisions would still have to be made. The risks of various energy systems are of different types that cannot all be reduced to common measures. Judgment will continue to dominate these decisions. This chapter reviews the known risks, indicates the difficulties of ascertaining some of the most important suspected risks, and recommends both practical courses of action in the face of uncertainty, and steps to improve judgment with better information. Among the major categories of risk considered are those relating to industrial operations, to atmospheric pollution, to shortage of water supply, and to change in climate. For each of these, we have considered to risks posed by energy systems based on fossil fuels, nuclear fuels, and solar energy. The chapter takes up the nature of risk and the government's actions to control the risks of energy systems. The risks posed by the major energy systems to health, agriculture, climate and water supply, and ecosystems are described, and wherever possible, compared.

NATURAL RESOURCES

REFER ALSO TO CITATION(S) 31149, 31155

RESEARCH, DEVELOPMENT, DEMONSTRATION, AND COMMERCIALIZATION

REFER ALSO TO CITATION(S) 30106, 30746

30753 (DOE/ET/60004—T1) **Abbreviated RD and D program portfolio selection workbook.** Boyd, D.W.; Cohan, D.; Regulinski, S.G. (Decision Focus, Inc., Palo Alto, CA (USA)). Dec 1979. Contract AC05-79ET60004. 214p. NTIS, PC A10/MF A01.

A workbook for implementing an abbreviated version of the RD and D portfolio selection methodology described in A Resource Allocation Methodology for Establishing RD and D Budgetary Priorities is presented. The purpose of the abbreviated methodology is to allow a fast, first-cut analysis of a set of programs and to provide a means of discovering important issues that deserve more detailed analysis. The use of the abbreviated methodology in the overall process of evaluating RD and D programs is outlined. The effect of the program on a process is represented by the process model. Those process cost and performance characteristics that are important to the market for an energy product are described. The product cost model takes the cost and performance characteristics and the feedstock price and calculates the cost of producing a unit of energy using the technology in question. The market model takes this cost, the demand for the energy product, and the characteristics of alternative sources of the same product, and specifies the market share captured by the new technology. From this point it is relatively straightforward to infer the impacts of the new technology on the energy system. The benefit model evaluates the impacts in a consistent way, given the cost of the Federal support.

30754 Time lag of energy innovation. Rudman, R.L.; Whipple, C.G. *EPRI J.;* 14-20(Apr 1980).

The time it takes for a new idea to emerge from the laboratory and dominate a commercial market depends on the type of technology involved, the size of devices to be manufactured, the complexity of the manufacturing system that must be set up, and the type of market to be penetrated. Change is swift in the electronics field because the technological base developed quickly, the devices are small and simple to manufacture, and new markets are rapidly evolving. Jet aircraft took only 10 years; nuclear over 30 years because of a unique technology and rising constraints. The development phases for future power technologies are plotted to illustrate the need for making energy decisions as early as possible to allow for the time lag.

30755 National Academy of Sciences: entering the energy debate. *EPRI J.;* 32-36(Apr 1980).

The National Academy of Sciences (NAS) has become a major voice in the energy debate even though it is not well known to the public. Originally created by the government during the Lincoln Administration, NAS was chartered to be self-governing and to act as an independent source of counsel to the government on matters of science and technology; according to its charter, it may not accept a fee for such services. Its organizational structure and functions are summarized and its unique features noted: (1) over 1200 distinguished scientists belong, (2) its resource is the whole U.S. scientific community, and (3) its National Research Council (NRC) ensures quality control. The Committee on Nuclear and Alternative Energy Sources (CONAES) report Energy in Transition: 1985 - 2010 is described to illustrate the caliber of studies and contributions made by the Academy. (DCK)

NUCLEAR ENERGY

REFER ALSO TO CITATION(S) 30228, 30618, 30672, 30674, 30766, 31371

30756 (DOE/ET/32052—T1) **International data collection and analysis. Task 2.** Fox, J.B.; Stobbs, J.J.; Collier, D.M.; Hobbs, J.S. (Nuclear Assurance Corp., Atlanta, GA (USA)). Apr 1979. Contract AC01-77ET32052. 153p. NTIS, PC A08/MF A01.

Extensive data regarding the energy, electricity, and nuclear activities of 28 non-US countries are compiled in Task I. Task 2 summarizes that extensive data in 9 key facets and presents it in an item-by-item format. Comparisons are made between the 28 countries in these facets: projected energy growth; indigenous energy resources; nuclear market; nuclear fuel cycle; commercial nuclear international ties; government nuclear policy; vested nuclear interests; economic resources; and research and test reactors. Comparisons with US data are made in these areas: projected energy growth; indigenous uranium and thorium resources; nuclear fuel cycle; and fuel-cycle status.

30757 (DOE/ET/32052—T2(Vol.1)) **International data collection and analysis. Task 1.** Fox, J.B.; Stobbs, J.J.; Collier, D.M.; Hobbs, J.S. (Nuclear Assurance Corp., Atlanta, GA (USA)). Apr 1979. Contract AC01-77ET32052. 250p. NTIS, PC A11/MF A01.

Commercial nuclear power has grown to the point where 13 nations now operate commercial nuclear power plants. Another four countries should join this list before the end of 1980. In the Nonproliferation Alternative Systems Assessment Program (NASAP), the US DOE is evaluating a series of alternate possible power systems to determine practical nuclear systems which could reduce proliferation risk while still maintaining the benefits of nuclear power. Part of that effort is the development of a data base denoting the energy needs, resources, technical capabilities, commitment to nuclear power, and projected future trends for various non-US countries. The data are presented by country for each of 28 non-US countries. Within each country section, six major groups of data exist: projected energy demands, indigenous energy resources, and related information; nuclear history, capability, commitment, and trends; nuclear technology capabilities and resources not related to electric power production; economic resources available for nuclear power development; government commitment to nuclear power development and role in nuclear facilities construction and operation; and nonnuclear energy and fuel supply facilities. A collection of data on energy reserves, production, and consumption for the 28 countries from the widest possible range of sources is presented. This volume contains data on Argentina, Australia, Austria, Belgium, and Brazil.

30758 (DOE/ET/32052—T2(Vol.2)) **International data collection and analysis. Task 1.** Fox, J.B.; Stobbs, J.J.; Collier, D.M.; Hobbs, J.S. (Nuclear Assurance Corp., Atlanta, GA (USA)). Apr 1979. Contract AC01-77ET32052. 356p. NTIS, PC A16/MF A01.

Commercial nuclear power has grown to the point where 13 nations now operate commercial nuclear power plants. Another four countries should join this list before the end of 1980. In the Nonproliferation Alternative Systems Assessment Program (NASAP), the US DOE is evaluating a series of alternate possible power systems. The objective is to determine practical nuclear systems which could reduce proliferation risk while still maintaining the benefits of nuclear power. Part of that effort is the development of a data base denoting the energy needs, resources, technical capabilities, commitment to nuclear power, and projected future trends for various non-US countries. The data are presented by country for each of 28 non-US counries. Data are compiled in this volume on Canada, Egypt, Federal Republic of Germany, Finland, and France.

30759 (DOE/ET/32052—T2(Vol.3)) **International data collection and analysis. Task 1.** Fox, J.B.; Stobbs, J.J.; Collier, D.M.; Hobbs, J.S. (Nuclear Assurance Corp., Atlanta, GA (USA)). Apr 1979. Contract AC01-77ET32052. 294p. NTIS, PC A13/MF A01.

Commercial nuclear power has grown to the point where 13 nations now operate commercial nuclear power plants. Another four countries should join this list before the end of 1980. In the Nonproliferation Alternative Systems Assessment Program (NASAP), the US DOE is evaluating a series of alternate possible power systems. The objective is to determine practical nuclear systems which could reduce proliferation risk while still maintaining the benefits of nuclear power. Part of that effort is the development of a data base denoting the energy needs, resources, technical capabilities, commitment to nuclear power, and projected future trends for various non-US countries. The data are presented by country for each of 28 non-US countries. Data are compiled in this volume for India, Indonesia, Iran, Israel, Italy, and Japan.

30760 (DOE/ET/32052—T2(Vol.5)) **International data collection and analysis. Task 1.** Fox, J.B.; Stobbs, J.J.; Collier, D.M.; Hobbs, J.S. (Nuclear Assurance Corp., Atlanta, GA (USA)). Apr 1979. Contract AC01-77ET32052. 290p. NTIS, PC A13/MF A01.

Commercial nuclear power has grown to the point where 13 nations now operate commercial nuclear power plants. Another four countries should join this list before the end of 1980. In the Nonproliferation Alternative Systems Assessment Program (NASAP), the US DOE is evaluating a series of alternate possible power systems. The objective is to determine practical nuclear systems which could reduce proliferation risk while still maintaining the benefits of nuclear power. Part of that effort is the development of a data base denoting the energy needs, resources, technical capabilities, commitment to nuclear power, and projected future trends for various non-US countries. The data are presented by country for each of 28 non-US countries. This volume contains compiled data on Sweden, Switzerland, Taiwan, United Kingdom, and Yugoslavia.

30761 **Nuclear power.** pp 210-344 of Energy in transition 1985-2010. Brooks, H.; Ginzton, E.L. (eds.). San Francisco, CA; W.H. Freeman and Co. (1980).

The committee concludes that the nature of the proliferation problem is such that even stopping nuclear power completely could not stop proliferation completely. Countries can acquire nuclear weapons by means independent of commercial nuclear power. It is reasonable to suppose if a country is strongly motivated to acquire nuclear weapons, it will have them by 2010, or soon thereafter, no matter how nuclear power is managed in the meantime. Unilateral and international diplomatic measures to reduce the motivations that lead to proliferation should be high on the foreign policy agenda of the United States. A mimimum antiproliferation prescription for the management of nuclear power is to try to raise the political barriers against proliferation through misuse of nuclear power by strengthening the Non-Proliferation Treaty, and to seek to raise the technological barriers by placing fuel-cycle operations involving weapons-usable material under international control. Any such measures should be considered tactics to slow the spread of nuclear weapons and thus earn time for the exercise of statesmanship. The committee concludes the following about technical factors that should be considered in formulating nuclear policy: (1) rate of growth of electricity use is a primary factor; (2) growth of conventional nuclear power will be limited by producibility of domestic uranium sources; (3) greater contribution of nuclear power beyond 400 GWe past the year 2000 can only be supported by advanced reactor systems; and (4) several different breeder reactors could serve in principle as candidates for an indefinitely sustainable source of energy.

WASTE HEAT UTILIZATION

REFER ALSO TO CITATION(S) 30595, 30797

CONSERVATION

REFER ALSO TO CITATION(S) 30154, 30363, 30747, 30764, 30765, 30797, 30800, 30803, 30804, 30805, 30807, 30810, 30811

30762 (DOE/PE—0020) **Low energy futures for the United States.** (Department of Energy, Washington, DC (USA). Assistant Secretary for Policy and Evaluation). Jun 1980. 152p. NTIS, PC A08/MF A01.

A range of available technologies and public policies which can reduce future US primary energy consumption to below current levels while contributing to continued improvements in the standard of living is explored. These recent analyses of low energy futures are difficult to compare because of differences in basic assumptions, methods of analysis, time frames, and definitions of economic sectors. Ten representative studies in three major end-use sectors are analyzed and compared, with emphasis on areas where consensus emerges or where uncertainty remains: buildings (thermal and electrical control systems; structural changes; and appliance and space-conditioning efficiencies); industry (waste heat recuperation; cogeneration of heat and electricity; electric motor drive; and materials recycling); and transportation (automobiles, light trucks, and vans; other passenger modes; and freight transportation). 56 references, 7 figures, 44 tables, 10 appendices.

30763 **Slowing the growth of energy consumption.** pp 75-127 of Energy in transition 1985-2010. Brooks, H.; Ginzton, E.L. (eds.). San Francisco, CA; W.H. Freeman and Co. (1980).

It is wrong to think of the nation's energy troubles as simply difficulties in energy supply. The real problem is finding a new balance between energy supply and energy demand, consistent with generally satisfactory overall economic performance. The generally rising real price of energy lends advantage to higher investments in both supply and conservation. The economic, environmental, and political trade-offs between these two coordinate efforts are not perfectly understood, but it is clear that in many activities throughout the economy it is cheaper now to invest in saving a Btu than in producing an additional one. As prices rise in the coming decades, more such opportunities will appear. Several economic analyses suggest that policies tending to reduce energy consumption per unit of output also tend to increase labor inputs. Thus, investing capital to increase energy efficiency is likely to generate more employment than investing the same capital to increase energy supply. While conservation measures can be selected with an eye to other national objectives - the most important of which may be social equity - they should not be unduly encumbered by competing demands. The resolution of social inequity, for example, deserves its own instruments. The amount of energy consumed in the future will be determined by economic evolution in the marketplace, and by events and forces many of which cannot now be foreseen. General directions can be selected for the growth of consumption, but attempts to plot the future in detail are likely to founder on the unexpected cumulative effects of many small decisions. The committee attempted here only to sketch possible patterns of growth, and to indicate how these might be affected by various near-term choices.

SUPPLY, DEMAND, AND FORECASTING

REFER ALSO TO CITATION(S) 30192, 30197, 30747, 30748, 30756, 30757, 30758, 30759, 30760, 30762, 30763, 30766, 30767, 30768, 30771, 30773, 30779, 30801, 30808, 30842

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 30167, 30189, 30190, 30545, 30746, 30750, 30752, 30761, 30772, 30782, 31371

30764 (DOE/RG—0034/1) **Public Utility Regulatory Policies Act of 1978. Annual report to Congress.** (Department of Energy, Washington, DC (USA). Economic Regulatory Administration). May 1980. 38p. NTIS, PC A03/MF A01.

The Public Utility Regulatory Policies Act of 1978 requires State regulatory authorities and nonregulated utilities to consider and make determinations regarding a set of Federal standards that show promise of furthering three statutory purposes: end-use conservation, utility efficiency, and equitable rates. PURPA sections 116 and 309 require the Secretary of Energy to report annually to Congress regarding the progress of these State regulatory authorities and nonregulated utilities in carrying out their PURPA obligations. DOE is also required to report on its own PURPA-related activities and to recommend any further Federal initiatives, including legislation, that may be necessary to carry out the purposes of the Act. In addition, section 206 of the Energy Conservation and Production Act of 1976 requires DOE to report annually regarding its activities under Title II of ECPA. This document fulfills these statutory reporting requirements for 1980, and assesses the progress made by State regulatory authorities and nonregulated utilities prior to June 30, 1979, in carrying out their PURPA duties and responsibilities. The report concludes that while there was more progress made on the regulatory standards than on the ratemaking standards, progress on all standards as of June 30, 1979, was limited. The report also describes DOE's efforts to assist State regulatory authorities and nonregulated utilities in carrying out their PURPA responsibilities.

30765 (DOE/RG—0034/2) **Public Utility Regulatory Policies Act of 1978. Annual report to Congress.** (Department of Energy, Washington, DC (USA). Economic Regulatory Administration). May 1980. 463p. NTIS, PC A20/MF A01.

Titles I and III of the Public Utility Regulatory Policies Act of 1978 (PURPA) establish retail regulatory policies for electric and natural gas utilities, respectively, aimed at achieving three purposes: conservation of energy supplied by electric and gas utilities; efficiency in the use of facilities and resources by these utilities; equitable rates to electricity and natural gas consumers. PURPA also contin-

ues the pilot utility implementation program, authorized under Title II of the Energy Conservation and Production ACT (ECPA), to encourage adoption of cost-based rates and efficient energy-management practices. The purpose of this report is twofold: (1) to summarize and analyze the progress that state regulatory authorities and certain nonregulated utilities have made in their consideration of the PURPA standards; and (2) to summarize the Department of Energy (DOE) activities relating to PURPA and ECPA. The report provides a broad overview and assessment of the status of electric and gas regulation nationwide, and thus helps provide the basis for congressional and DOE actions targeted on the utility industry to address pressing national energy problems.

30766 Energy in transition 1985-2010. Brooks, H.; Ginzton, E.L. (eds.). Contract EX-76-C-10-3784. San Francisco, CA; W.H. Freeman and Co. (1980). 714p. $24.95.

Final report of the Committee on Nuclear and Alternative Energy Systems, National Research Council.

The impetus for this study was an April 1, 1975 letter from Dr. Robert C. Seamans, then Administrator of ERDA to Dr. Philip Handler, Chairman, National Research Council, National Academy of Sciences, requesting that NRC undertake a detailed and objective analysis of the risks and benefits associated with alternative conventional and breeder reactors as sources of power. Eventually the governing body of the NRC indicated that it would prefer a comprehensive and objective study of the role of nuclear power in the context of alternative energy systems. These expanded terms of reference were acceptable to ERDA, so specified in the resultant contract, and administrative management within the NRC was assigned to the Assembly of Engineering. The CONAES Committee, co-chaired by Dr. Harvey Brooks of Harvard University and Edward L. Ginzton of Varian Associates was charged with a detailed analysis of all aspects of the nation's energy situation. The Committee of 14 members brought into being a set of 4 major panels supported by 22 resource groups and a number of consultants, thereby acquiring the knowledge and insights of about 300 additional individuals of highly diverse backgrounds. During September 1978 funds provided by ERDA and its successor, DOE, were exhausted and the project was completed via private funds of NRC in the amount of about $300,000. The study, to assess the appropriate roles of nuclear and alternative energy systems in the transition period, 1985-2010, will hopefully assist the legislative and executive branches of government as well as the American people as a whole, in formulating energy policy. A separate abstract was prepared for each of the 11 chapters.

30767 Overview. pp 1-74 of Energy in Transition 1985-2010. Brooks, H.; Ginzton, E.L. (eds.). San Francisco, CA; W.H. Freeman and Co. (1980).

This committee studied at length the many factors and relationships involved in the nation's energy future. It offers here some technical and economic observations that decision makers may find useful as they develop energy policy in the larger context of the future of our society. Its observations focus on (1) the prime importance of energy conservation; (2) the critical near-term problem of fluid-fuel supply; (3) the desirability of a balanced combination of coal and nuclear fission as the only large-scale intermediate-term options for electricity generation; (4) the need to keep the breeder option open; and (5) the importance of investing now in research and development to ensure the availability of a strong range of new energy options sustainable over the long term. Policy changes both to improve energy efficiency and to enhance the supply of alternatives to imported oil will be necessary. Continuation of artificially low prices would inevitably widen the gap between domestic supply and demand, and this could only be made up by increased imports, a policy that would be increasingly hazardous and difficult to sustain. The most vital of these observations is the importance of energy demand considerations in planning future energy supplies. There is great flexibility in the technical efficiency of energy use, and there is correspondingly great scope for reducing the growth of energy consumption without appreciable sacrifices in the growth of GNP or in nonenergy consumption patterns. Indeed, as energy prices rise, the nation will face important losses in economic growth if we do not significantly increase the economy's energy efficiency. Reducing the growth of energy demand should be accorded the highest priority in national energy policy. 37 references.

30768 US energy policy in the global economic context. pp 500-528 of Energy in transition 1985-2010. Brooks, H.; Ginzton, E.L. (eds.). San Francisco, CA; W.H. Freeman and Co. (1980).

The energy upheavals in the winter of 1973-1974 made it clear that the United States is strongly affected by energy developments abroad. It is no less obvious that US energy policies, especially in oil and nuclear power, in turn affect other countries. This chapter deals with some international aspects of American energy policy, focusing particularly on the world supply and demand situation. The chapter opens with an overview of world energy developments before the 1973-1974 oil price increase, an overview that brings out the growing dependence on oil and gas. It then reviews the consequences of that price increase. A discussion of the magnitude of global energy resources serves as an introduction to the prospects for energy relations between the United States and the rest of the world.

30769 Part I of Energy Notes presented to the House of Commons. *Energiespectrum;* 3: No. 10, 242-252(Oct 1979). (In Dutch).

The article is a summary of Part I of the Notes on Energy Policy, presented by the Netherlands Minster for Economic Affairs to the House of Commons on 18th September 1979. These notes deal with energy policy in general terms until the year 2000, and particularly with policy regarding energy savings, gas, oil and energy investigations. The necessity of making use of more energy sources is emphasized. These notes have been produced due to the growing concern of the Netherlands energy provision in relation to the worsening world energy situation.

FOSSIL FUELS

REFER ALSO TO CITATION(S) 31115

COAL

REFER ALSO TO CITATION(S) 30144, 30154, 30167

PETROLEUM

REFER ALSO TO CITATION(S) 30189, 30190, 30191, 30192, 30193, 30194, 30197

30770 (LPR—21(P-23A)) Use of standard regression analysis for relating bonus bids and oil/gas production: Federal offshore leases. Berger, P.D.; Lohrenz, J. (Geological Survey, Denver, CO (USA). Conservation Div.). Jun 1980. 19p. Geological Survey, P.O. Box 25046, Federal Center Bldg. 85, Denver, CO 80225.

Multiple linear regression analysis has been used to study bidding and production data for Federal offshore oil and gas leases. Policy value conclusions have been stated therefrom. We, firstly, address the applicability of the inherent assumptions of normality and homoscedasticity finding the assumptions unsupported and questioning the statistical inferences which could otherwise be drawn. Secondly, even given the legitimacy of the assumptions and the usual statistical inferences from multiple linear regression results, we show the conclusions are volatilely sensitive. We are led to a strong assertion that quantitative assessment of the assumptions of normality and homoscedasticity be a mandatory requirement for the proper understanding and use, if indeed any is possible, of multiple linear regression analysis results for drawing policy value conclusions from data with the statistical behavior of Federal offshore oil and gas lease data.

30771 Oil and gas supply. pp 128-145 of Energy in transition 1985-2010. Brooks, H.; Ginzton, E.L. (eds.). San Francisco, CA; W.H. Freeman and Co. (1980).

The analyses underlying the chapter suggest on balance that domestic supplies of liquid and gaseous fuels will decline further while demand continues to increase. In fact, the study's scenarios suggest the possibility, under even moderate energy-growth assumptions, of brief but recurrent shortages of oil and perhaps of gas. Such shortages could have the same transient character as the episodes following the 1973 OPEC embargo, those experienced during the cold winter of 1976-1977, and the gasoline shortages of 1979. Whether this problem materializes will depend to a large extent on the maintenance of price controls, which discourage production and encourage consumption. If it does materialize, the government must see to it that available supplies of specific fossil fuels go to those applications for which they are best suited and most needed. Usually, though not invariably, this will mean reserving natural gas for space heating and special applications in industry, oil for transportation and petrochemicals, and coal for generating steam and electricity. While the allocation of increasingly scarce fuels could probably not be left entirely to the market in an emergency situation, care must be taken to prevent distortions of the price mechanisms that result in false signals to consumers and producers and thus aggravate the long-term problem. Any allocation system should preserve a reasonable balance between household use and industrial or commercial use; giving households absolute priority in natural gas, for instance, may lead to avoidable unemployment and loss of nonenergy output. Even those members of CONAES who are convinced that the oil and natural gas era is coming to an end feel that improved domestic production is essential to permit a transition to sustainable long-term energy sources.

NATURAL GAS

REFER ALSO TO CITATION(S) 30193, 30194, 30197, 30200, 30201, 30770, 30771

30772 (DOE/RG—0035/2) **Public Utility Regulatory Policies Act of 1978: Natural Gas Rate Design Study.** (Department of Energy, Washington, DC (USA). Economic Regulatory Administration). May 1980. 616p. NTIS, PC A99/MF A01.

First, the comments on May 3, 1979 Notice of Inquiry of DOE relating to the Gas Utility Rate Design Study Required by Section 306 of PURPA are presented. Then, comments on the following are included: (1) ICF Gas Utility Model, Gas Utility Model Data Outputs, Scenario Design; (2) Interim Model Development Report with Example Case Illustrations; (3) Interim Report on Simulation of Seven Rate Forms; (4) Methodology for Assessing the Impacts of Alternative Rate Designs on Industrial Energy Use; (5) Simulation of Marginal-Cost-Based Natural Gas Rates; and (6) Preliminary Discussion Draft of the Gas Rate Design Study. Among the most frequent comments expressed were the following: (a) the public should be given the opportunity to review the final report prior to its submission to Congress; (b) results based on a single computer model of only four hypothetical utility situations cannot be used for policy-making purposes for individual companies or the entire gas industry; (c) there has been an unobjective treatment of traditional and economic cost rate structures; the practical difficulties and potential detrimental consequences of economic cost rates are not fully disclosed; and (d) it is erroneous to assume that end users, particularly residential customers, are influenced by price signals in the rate structure, as opposed to the total bill.

ELECTRIC POWER

REFER ALSO TO CITATION(S) 30610, 30754, 30756, 30757, 30758, 30759, 30760, 30773

30773 (DOE/ET/32052—T2(Vol.4)) **International data collection and analysis. Task 1.** (Nuclear Assurance Corp., Atlanta, GA (USA)). Apr 1979. Contract AC01-77ET32052. 277p. NTIS, PC A13/MF A01.

Commercial nuclear power has grown to the point where 13 nations now operate commercial nuclear power plants. Another four countries should join this list before the end of 1980. In the Nonproliferation Alternative Systems Assessment Program (NASAP), the US DOE is evaluating a series of alternate possible power systems. The objective is to determine practical nuclear systems which could reduce proliferation risk while still maintaining the benefits of nuclear power. Part of that effort is the development of a data base denoting the energy needs, resources, technical capabilities, commitment to nuclear power, and projected future trends for various non-US countries. The data are presented by country for each of 28 non-US countries. This volume contains compiled data on Mexico, Netherlands, Pakistan, Philippines, South Africa, South Korea, and Spain.

30774 (EPRI-EA—1420) **Combined energy models.** Hogan, W.W.; Weyant, J.P. (Harvard Univ., Cambridge, MA (USA). Energy and Environmental Policy Center). May 1980. 126p. NTIS, PC A07/MF A01.

The electric power industry, which is affected by nearly every major energy policy decision and which is confronted with its own difficult policy and planning problems, has been at the forefront of the development, analysis, and use of large-scale energy models. The research on the methodology of large-scale energy models has improved the capability to understand and manipulate existing models, and has created the capability for efficiently building new models or adapting old models to the study of new problems. Most large-scale models of any type are highly structured, and large-scale energy models are no exception. Typically, the model grows through the combination of several smaller models of individual component sectors. These combined energy models build on the extensive work invested in modeling the separate sectors, adding the capability of the combined system to characterize the sometimes unexpected effects of feedbacks through the interactions of the several model components. An examination of the methodology employed in different combined energy modeling efforts reveals a common framework for organizing the models, establishing the properties of the solutions, and manipulating the model in the study of particular policy and planning problems. Within this general framework, the many modeling techniques found in practice are described, how these techniques can be applied to other models are shown, and an approach to the development and application of combined models is outlined. The results should serve as a guide to the use of the many models developed by and available to energy decision makers in the electric power industry, other energy industries, and the public sector.

30775 (EPRI-EA—1462) **Integrated models for R and D planning. Interim report.** Barrager, S.M.; Haas, S.M.; Oman, D.B.; Marshalla, R.A. (Decision Focus, Inc., Palo Alto, CA (USA)). Jul 1980. 36p. NTIS, PC A03/MF A01.

This project phase has sponsored the development and testing of an energy modeling system made up of generic model logic components and standardized computer software offering flexibility and user-access. Elegant model logic extensions in the areas of rate design, cost-of-service pricing, and end-use load shape representations have also been implemented. The current report reviews the theory underlying energy modeling systems of this type, and describes the model logic enhancements in some detail.

30776 (RAND/R--2508-DOE/DWP) **British industrial response to the peak-load pricing of electricity.** Acton, J.P.; Gelbard, E.H.; Hosek, J.R.; McKay, D.J. (RAND Corp., Santa Monica, CA (USA)). Feb 1980. Contract AC01-79PE70078. 90p. NTIS, PC A05/MF A01.

This report examines selected aspects of British industrial experience with peak-load pricing of electricity. Industrial users interviewed had had peak-load pricing in effect for more than 15 years. Industries represented included chemicals, industrial gases, cement manufacturing, pulp and paper, steel, and other miscellaneous industries. Together they represent about 35% of electricity purchases by British industrial customers. Some of the reasons for present US interest in the potential industrial response to time-of-use pricing and the rationale for looking to European experience for guidance are highlighted. Section II summarizes the principal features of electricity rate structures for industrial customers in England and Wales. Section III presents a brief description of the methodology and the results of interviews. The section is organized around 7 major industries which represent a number of generic processes found in the US and in other industrial economies. Section IV summarizes the principal findings for the 7 industries interviewed.

30777 **Putting baseload to work on the night shift.** Catron, J.; Schneider, T. *EPRI J.;* 6-13(Apr 1980).

Energy storage could open the door to the full use of baseload power, allowing the excess output produced at night to be shifted to daytime consumption. This would help utilities and their customers manage electric load cycles better, shift demand from the scarce fuels to more-plentiful and less-costly domestic resources, and assist the gradual integration of solar energy into utility systems. A variety of technologies for both system-load storage and end-use storage is being developed. Economics and regulatory strategies will affect how energy storage is used.

30778 **Pricing of public-utility service with temporally interdependent demands.** Uri, N.D. (Department of Energy, Washington, DC). *J. Environ. Manage.;* **10**: No. 1, 25-36(Jan 1980).

The principal question addressed in this paper is the optimal price profile for a regulated public utility where the demand varies spatially as well as temporally, where demands are temporally interdependent, and where there are several spatially separated plants with different operating characteristics available for generation. No simple cost-based solution proved possible. Under regulatory constraint, regardless of its form, price will be reduced as the output of the public utility is expanded. The method of regulation does make a difference in the distribution of price reductions between consumers.

30779 **Directional causality in the demand for electrical energy in the United States.** Uri, N.D. *Energy Syst. Policy;* **3**: No. 4, 353-365(1980).

The majority of studies on the demand for electrical energy are done with single equation models, but this paper demonstrates that quantity of electrical energy demand is a function of price and that price is causally related to quantity in the residential sector. This causal relationship implies that it is not sufficient to use single-equation models to arrive at demand estimates. Since bidirectional causality cannot be statistically rejected, any estimation of demand for electrical energy must be made by a simultaneous-equation system to avoid specification errors and their associated problems. 7 references, 2 figures, 3 tables.

30780 **Survey of commercial/industrial consumers on mandatory time-of-use electricity rates.** San Francisco, CA; Elrick and Lavidge, Inc. (1980). 163p. EPRI, Palo Alto, CA.

Research was conducted via questionnaire on customer response to mandatory time-of-use electricity rates. The information came from 5 utilities that had been under mandated TOU rates for at least one year, namely: Commonwealth Edison, Pacific Gas and Electric, Southern California Edison, Wisconsin Electric Power Company, and Wisconsin Power and Light. The principal objectives were to secure information directly from commercial and industrial customers which can be used to answer the following questions: (1) what level of understanding do customers have about the mandatory time-of-use program in which they are participating; e.g., to what extent do they know their peak and off-peak hours and days, and the

rates they are being charged during those times; (2) to what extent do customers like or dislike TOU rates compared with the rate or pricing system under which they were charged previously; (3) what effect, if any, have the TOU rates had on customers' electricity-use patterns (4) to what extent have customers shifted demand (kW) and energy usage (kWh) from on peak to off-peak times; (5) what uses, if any, have been shifted from peak to off-peak times; and (6) what changes, if any, in work hours, work shifts, or usage of demand-control systems have been made by businesses. Most of the report is devoted to the analysis and results of the findings.

ELECTRIC POWER GENERATION

REFER ALSO TO CITATION(S) 30784

CONSUMPTION AND UTILIZATION

REFER ALSO TO CITATION(S) 30808, 30809

UNCONVENTIONAL SOURCES AND POWER GENERATION

REFER ALSO TO CITATION(S) 30766

30781 (SERI/TR—744-450) **Decentralized Energy Studies: compendium of U.S. studies and projects.** Quinn, J.; Ohi, J.M. (Solar Energy Research Inst., Golden, CO (USA)). Jun 1980. Contract AC02-77CH00178. 47p. NTIS, PC A03/MF A01.

This compendium was prepared as a part of the Decentralized Energy Studies task at the Solar Energy Research Institute. The compendium lists and briefly describes a number of studies, programs, and projects that involve decentralized energy systems. The purpose is to provide information about research activities in decentralized energy systems to researchers, government officials, and interested citizens. A contact person or address is given for each of the activities listed so that interested readers can obtain more information.

SOLAR

REFER ALSO TO CITATION(S) 30363, 30365, 30366, 30368, 30369, 30371

30782 **Solar energy.** pp 345-384 of Energy in transition 1985-2010. Brooks, H.; Ginzton, E.L. (eds.). San Francisco, CA; W.H. Freeman and Co. (1980).

The committee's conclusions are: (1) The aim of the government's solar energy program should be to place the nation in the best possible position to make realistic choices among solar and other possible long-term options when choices become necessary. This requires continuing support of research and development of many solar technologies. (2) In the intermediate-term future, the direct use of solar heat can contribute significantly to the nation's energy system. Solar heating technologies should be viewed, along with many conservation measures, as means of reducing domestic use of exhaustible resources. (3) Under present market conditions, solar heating systems are usually not competitive with other available technologies, and therefore market forces alone will bring about little use of solar energy by 2010 - probably less than 6 quads even if average energy prices quadruple. Nevertheless, important social benefits would accrue from the early implementation of these systems. (4) Many solar energy applications require long-term development, and these technologies should properly be compared with breeder reactors or fusion. (5) The cost picture for a number of solar technologies is likely to change radically in the future, with successes and failures in development. (6) An imbalance exists in the Federal solar energy program in favor of technologies to produce electricity at the expense of those to produce fuels. (7) The diversity of solar technologies is so great that it is difficult to make decisions among alternatives in a centralized way. To a great extent, the actual choice of which solar technologies to deploy should be made in as decentralized a manner as possible.

GEOTHERMAL

REFER ALSO TO CITATION(S) 30545, 30564

OTHER

REFER ALSO TO CITATION(S) 30402, 30406, 30581, 30583, 30784, 30842

30783 (DOE/CS/20094—01) **Dutchess County Resource Recovery Task Force report: Dutchess County Pyrolysis Program.** (Department of Energy, Washington, DC (USA). Office of Buildings and Community Systems). Jul 1980. Contract FG01-78CS20094. 461p. NTIS, PC A20/MF A01.

Dutchess County initiated development of a long-range master plan for Solid Waste Management in 1971. The plan included development of a resource recovery facility to service the municipalities in the County population center. Based on early recommendations, a pyrolysis facility employing Purox technology was to be implemented. A feasibility study, paid for by County funds was completed in 1975. The study provided siting recommendations, estimation of available waste, and preliminary facility design. Because of various considerations, the project was not developed. Under the Department of Energy grant, the County reassessed the feasibility of a resource recovery facility, with emphasis on confirming previous conclusions supporting the Purox technology, waste availability, energy recovery and sale and siting of the plant. The conclusions reached in the new study were: a resource recovery facility is feasible for the County; sufficient waste for such a facility is available and subject to control; While Purox technology was feasible it is not the most appropriate available technoloy for the County; that mass burning with steam recovery is the most appropriate technology; and that resource recovery while presently more expensive than landfilling, represents the only cost effective, energy efficient, and environmentally sound way to handle the solid waste problem in the County.

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ENERGY CONVERSION

MHD GENERATORS

30784 **MHD: direct channel from heat to electricity.** Lihach, N.; Zygielbaum, P.; Lowenstein, A. *EPRI J.*; 21-25(Apr 1980).

Magnetohydrodynamics (MHD) combined with conventional power generation is promising, but several engineering and technological problems must be solved before it can compete in the electric utility market. A combined MHD topping cycle and steam-electric bottoming cycle would raise the efficiency of a coal-fired plant from 35 to as high as 50 percent. Coal requirements would be lowered and internal sulfur oxide control is possible. Some of the components for MHD generation can be adapted from industrial applications and are already available, but many new components must be designed. Schematic drawings illustrate the engineering complexities of an MHD plant. (DCK)

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 30787

30785 (DOE/NASA/0052—79/1) **Parametric study of potential early commercial MHD power plants.** Marston, C.H.; Alyea, F.N.; Bender, D.J. (General Electric Co., Philadelphia, PA (USA). Space Sciences Lab.). Feb 1980. Contract AI01-77ET10769. 372p. (NASA-CR—159634). NTIS, PC A16/MF A01.

A parametric study was performed to determine performance and cost of moderate technology coal-fired Open Cycle MHD/steam power plant designs which can be expected to require a shorter development time and have a lower development cost than previously-considered mature OCMHD/Steam plants. Three base cases were considered: Base Case 1 had an indirectly-fired high temperature air heater (HTAH) subsystem delivering air at 2700 F; fired by a state-of-the-art atmospheric pressure gasifier; Base Case 2 had an indirectly-fired HTAH subsystem delivering air at 3000 F; in Base Case 3 the HTAH subsystem was deleted and oxygen enrichment was used to obtain requisite MHD combustion temperature. Coal pile to bus bar efficiencies in Base Case 1 ranged from 41.4% to 42.9%, and cost of electricity (COE) was highest of the three base cases. For Base Case 2 the efficiency range was 42.0% to 45.6%, and COE was lowest. For Base Case 3 the efficiency range was 42.9% to 44.4%, and COE was intermediate. The best parametric cases in Base Cases 2 and 3 are recommended for conceptual design. Eventual choice between these approaches is dependent on further evaluation of the tradeoffs among HTAH development risk, O_2 plant integration and further refinements of comparative costs.

30786 **MHD generating system.** Petrick, M.; Pierson, E.S.; Schreiner, F. (to Dept. of Energy). US Patent Patent 4,200,815. 29 Apr 1980. Filed date 19 Sep 1978. 6p.

PAT-APPL-943,827.

According to the present invention, coal combustion gas is the primary working fluid and copper or a copper alloy is the electrodynamic fluid in the MHD generator, thereby eliminating the heat exchangers between the combustor and the liquid-metal MHD working fluids, allowing the use of a conventional coalfired steam bottoming plant, and making the plant simpler, more efficient and cheaper. In operation, the gas and liquid are combined in a mixer and

the resulting two-phase mixture enters the MHD generator. The MHD generator acts as a turbine and electric generator in one unit wherein the gas expands, drives the liquid across the magnetic field and thus generates electrical power. The gas and liquid are separated, and the available energy in the gas is recovered before the gas is exhausted to the atmosphere. Where the combustion gas contains sulfur, oxygen is bubbled through a side loop to remove sulfur therefrom as a concentrated stream of sulfur dioxide. The combustor is operated substoichiometrically to control the oxide level in the copper.

PERFORMANCE AND TESTING

30787 (FE—2895-7) **MHD high performance demonstration experiment. Quarterly progress report, October 1-December 31, 1979.** (Arnold Engineering Development Center, Arnold Air Force Station, TN (USA)). Jan 1980. Contract ET-78-I-01-2895. 45p. NTIS, PC A03/MF A01.

The objective of this experimental research, started late in 1973, is to demonstrate the attainment of MHD performance on a sufficiently large scale to verify that the projected efficiency of the commercial MHD concept is attainable. To perform the experiment, an existing facility at the Arnold Engineering Development Center (AEDC) was refurbished and the new systems required for performing the experiment have been designed and built. In particular, the largest systems which have required the greatest expenditure of resources are the generator channel and the 6 Tesla (T) cryogenically cooled magnet. The entire HPDE system is now complete and shakedown testing of the magnet and flow train have been completed. During the period between October 1, 1979, and December 31, 1979, operation of the HPDE system in the Faraday power producing mode has continued. A peak power of about 18 MW was produced with a magnetic field of 2.8 T. Significant results which were obtained involved a definition of the transverse voltage characteristics, including the voltage drop near the electrode walls, and a definition of the fluid flow through the channel and diffuser. Several operational problems were encountered including erosion of heat sink components of the burner and channel entrance and Hall potential shorting at the aft end of the channel and diffuser. Required hardware procurement and modification were initiated by the end of the quarter to solve these problems. Progress is reported.

DUCT ENGINEERING AND FLUID DYNAMICS

30788 (FE—15529-6) **MHD electrode development. Quarterly report, January-March 31, 1980.** (Westinghouse Electric Corp., Pittsburgh, PA (USA). Advanced Energy Systems Div.). Apr 1980. Contract AC01-79ET15529. 67p. NTIS, PC A04/MF A01.

Progress on the program to develop improved electrode designs for open-cycle coal-fired MHD generators is reported. Platinum capped anodes and iron cathodes, operating in the slagging hot mode, have been included in WESTF Test 43. Further results of bonding studies in support of this test are presented. The results of thermal diffusivity measurements made by Battelle Pacific Northwest Laboratory (BPNL) of super-hot hafnia electrode and indium oxide current leadout materials are reported. Laboratory electrochemical corrosion tests have been continued. Results reported herein indicate that Fe_3O_4 additions are effective in reducing polarization in Western slags. In comparison with cobalt oxide additions, the Fe_3O_4 addition provides significant cost advantages. During this period, significant WESTF operations included WESTF Test 47, 42, 43 and 49. This test sequence included tests of: slagging cold metallics in the MTS II test section; hafnia and zirconia coupons in the WESTF test section (non-slagging super-hot conditions); platinum/iron run under slagging hot conditions in the WESTF test section, and, a test of the 0.5 $SrZrO_3$.0.5 ($Sr_{.25}La_{.75}FeO_3$) material in the non-slagging super-hot mode in the MTS II test section. Upon completion of WESTF Test 49, facility test operations were suspended and modifications of the facility, to support the addition of a 3 Tesla magnet, initiated. The status of design, procurement and modification activities is presented.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 30929

FUEL CELLS

DESIGN AND DEVELOPMENT

30789 (CONF-800324—3) **Molten carbonate fuel cell programs in the United States.** Ackerman, J.P. (Argonne National Lab., IL (USA)). 1980. Contract W-31-109-ENG-38. 17p. NTIS, PC A02/MF A01.

From Seminar on electrochemical systems: batteries and fuel cells; Fortaleza-Ceara, Brazil (2 Mar 1980).

The environmental, performance, and economic aspects of molten carbonate fuel cell power plants are discussed. Design, components, and operation of molten carbonate fuel cells are discussed, and US research is outlined. (WHK)

30790 (DOE/ET/15440—1) **Development of molten carbonate fuel cell power plant technology. Quarterly technical progress report No. 1, October 1-December 31, 1979.** Healy, H.C.; Sanderson, R.A.; Wertheim, R.J. (United Technologies Corp., South Windsor, CT (USA). Power Systems Div.). Mar 1980. Contract AC01-79ET15440. 80p. NTIS, PC A05/MF A01.

The overall objective of this 29-month program is to develop and verify the design of a prototype molten carbonate fuel cell stack which meets the requirements of 1990's competitive coal-fired electrical utility central station or industrial cogeneration power plants. During the first quarter, effort was initiated in all four major areas: Task 1 - system studies to define the reference power plant design; Task 2 - cell and stack design, development and verification; Task 3 - preparation for fabrication and testing of the full-scale prototype stack; and Task-4 developing the capability for operation of stacks on coal-derived gas. In the system study task, a study baseline fuel cell system and module configuration were established. Studies to determine user requirements and to characterize the fuel cell power block and coal gasifier subsystems were initiated. Cell stack design was initiated with completion of preliminary design requirements for the cell cathodes. Laboratory tests were also initiated to identify alternative materials for separator plates, reactant manifold seals, and electrolyte tile fillers. A mechanical tape casting technique for producing 18 x 24 inch sheets of electrolyte matrix tape was successfully demonstrated in Task 3. In Task 4, theoretical and experimental studies were initiated to define the effects of known sulfur contaminants on cell performance. A literature survey was initiated to identify other possible contaminants. Planning and design efforts for construction of a mobile cell test unit were initiated. The mobile unit will be used to verify the molten carbonate cell's ability to operate on gasified coal by tests at a gasifier site.

30791 (DOE/ET/17019—1) **Development of molten carbonate fuel cell power plant. Quarterly technical progress report, February 1-April 30, 1980.** Peterson, J.R. (General Electric Co., Schenectady, NY (USA). Energy Systems Programs Dept.). 1980. Contract AC02-80ET17019. 140p. NTIS, PC A07/MF A01.

Work has been initiated during this first quarter under all four program tasks and by all major participants as described. Task 1.0 activity (establish power plant reference design) concentrated upon definition of user requirements and establishment of power plant subsystem alternatives and characteristics. Task 2.0 work (stack and cell design development and verification) was initiated with a heavy emphasis upon test facilities preparation. A total of 27 laboratory cells were operated during this reporting period and a total of nine cells continued on test at the end of the quarter. Investigation of alternative anode and cathode materials proceeded; a dual-porosity anode was fabricated and tested. Over 10,000 endurance hours on a state-of-the-art cell carried-over from a previous program has been achieved and 1500 hours endurance has been obtained with sheet metal cells. Results presented for electrolyte structure development include comparative data for spray-dried and modified aqueous slurry process powders. Shake-down tests with a rotating disc electrode apparatus for fundamental measurements are described. Concept designs for both prototype and subscale stacks have been identified. Task 3.0 effort (development capability for full-scale stack tests) included preparation of an overall test plan to commercialization for molten carbonate fuel cells and of a functional specification for the tenth-scale stack test facility; drafts of both documents were completed for internal review. Cost-effective manufacturing assessment of available designs and processes was initiated. Task 4.0 work (develop capabilities for operation of stacks on coal-derived gas) included gathering of available contaminants concentration and effects information and preparation of initial projections of contaminant ranges and concentrations. Accomplishments to date and activities planned for the next quarter are described.

30792 (EPRI-EM—1365) **Evaluation of DIGAS cooling for utility fuel cell power plants. Final report.** Somers, E.V.; Grimble, R.E.; Vidt, E.J. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Center). Mar 1980. 53p. NTIS, PC A04/MF A01.

This project assesses the technical and economic feasibility of pressurized gas-cooled fuel cell stacks for dispersed electric utility power plants. The gas-cooling concept, termed DIGAS, recirculates cathode vent gas through the fuel stack to cool the cells. The heat extracted by the cooling gas is then used to generate steam for the fuel processor and other uses. The efficient recovery of the heat at high temperature requires recirculation of most of the gas exhausted from the fuel cell through an external heat exchanger with ratios of the recirculating-gas-to-makeup-air of between 15:1 to 60:1. The evaluation developed is aimed at determining conceptual sizes and ratings and preliminary costs of the heat exchangers and recirculating fan in the recirculating gas loop, and at evaluating performance

of 5 MW fuel cell power plants utilizing the DIGAS concept. Several conceptual designs of 5 MW DIGAS-cooled phosphoric-acid fuel-cell power plants operating on a naphta-type hydrocarbon are developed that yielded heat rates between 8700 and 9100 Btu per kWh. The conceptual design of a 10 kW proof-of-concept demonstration subsystem is also prepared. The operating characteristics of the fuel cell and fuel processor which greatly affect the recirculating loop operation and, in turn, the plant heat rate and piping configuration are: average temperature and pressure in the fuel cell; saturation pressure and temperature of the steam for the reformer; and the molar ratio of reformer steam-to-carbon in the fuel to the fuel processor. Conceptual plant designs show that naphtha-fueled phosphoric-acid fuel-cell power plants that are DIGAS-cooled should attain good heat rate performance with economically acceptable recirculation loop piping configurations.

30793 (LMSC-D—678426) **Rechargeable alkaline zinc/ferricyanide battery. Final report, 29 September 1978-28 September 1979.** Adams, G.B.; Hollandsworth, R.P.; Webber, B.D. (Lockheed Missiles and Space Co., Palo Alto, CA (USA). Lockheed Palo Alto Research Lab.). 1979. Contract EM-78-C-01-5163. 212p. NTIS, PC A10/MF A01.

First-year contract effort was directed primarily to assessing technical and economic feasibility of the alkaline zinc/ferricyanide rechargeable battery for utility load-leveling applications. This battery meets the requirements for this application with cell voltages of 1.94 V on charge and 1.78 V on discharge (35 mA/cm^2) at 40°C, with peak power density of 4.5 kW/m^2. Mean energy efficiency is 84% at 760 and 86% at 1110 4-hour cycles in full-cell and redox half-cell cycling, respectively. An updated, upgraded economic analysis suggests a battery selling price of $32/kWh, installed price of $230/kW, and footprint of 8.7 kWh/ft^2 as realistic goals for a 20-MW, 100-MWh system. A major effort was successfully completed on design, construction, programing, and debugging of a microprocessor-controlled battery cycling system, which is the heart of the cell cycling test facility developed on this project. Other technical areas addressed include electrode substrate evaluation, solubilities and conductivities of zinc oxide and sodium ferro- and ferricyanide in sodium hydroxide electrolytes, mechanism of the slow chemical deligation of alkaline ferricyanide and its reversal, optimal compositions of zincate and iron redox electrolytes, effect of electrolyte flow rate and additions on quality of zinc electrodeposits, cell and electrode design and fabrication, and full and half-cell cyclic testing. Significant technical progress was made in concept configuration and improving performance of the alkaline zinc/ferricyanide battery. 71 figures, 12 tables.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 30792, 30793

30794 (LBL—10799) **Oxygen reduction on supported Pt alloys and intermetallic compounds in phosphoric acid.** Ross, P.N. Jr. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1980. Contract W-7405-ENG-48. 85p. NTIS, PC A05/MF A01.

The objectives of this study are to conduct kinetic studies at all experimental conditions of interest on a standard, state-of-the-art Pt fuel cell electrocatalyst to establish a control activity level. The electrocatalyst chosen for this purpose was a 10 w/o Pt on Vulcan XC-72R carbon black supplied by Prototech. Pt binary alloys were prepared in supported form with the alloying constituents Ti, Zr, Hf, V, Nb, Ta, and also Al, Re, and W. The resulting catalysts were characterized by transmission electron microscopy (TEM), x-ray emission (XES), selected area microdiffraction (SAD) and conventional x-ray powder diffraction (XRD). The alloys were examined for stability in hot H_3PO_4 at electrode potentials of practical interest. The kinetic characteristics of oxygen reduction on (stable) Pt alloys were determined and compared to the state-of-the-art Pt fuel cell catalyst material. Procedures are described, and results are presented and discussed. (WHK)

APPLICATIONS

REFER ALSO TO CITATION(S) 30794

ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

REFER ALSO TO CITATION(S) 30363

BUILDINGS

REFER ALSO TO CITATION(S) 30762

30795 (CONF-780249—, pp 164-176) **Passive cooling systems in Iranian architecture.** Bahadori, M.N. (Pahlavi Univ., Shiraz, Iran). Oct 1978.

From 3. workshop on the use of solar energy for the cooling of buildings; San Francisco, CA, USA (15 Feb 1978).

In Iran certain traditional building designs circulate cool air through the building and can even keep water cold and ice frozen from the winter until the height of the long, hot summer of the country's arid central and eastern plains. They do so without any input of energy other than that of the natural environment; hence they can be characterized as passive cooling systems. Some of these systems, for example curved-roof systems, were incorporated in buildings as early as 3000 B.C.; others, for example wind tower systems, the cistern and ice maker, may not have appeared until about 900 A.D. Many of the passive cooling systems are still in use at present. The design and operation of the wind tower cooling system, the cistern cooling system, and the nocturnal radiative cooling ice maker are described. (WHK)

30796 (DOE/CS/23337—1) **Study of the test method for prediction of air conditioning equipment seasonal performance.** Thomas, S.B. (Purdue Univ., Lafayette, IN (USA)). May 1980. Contract AC02-80CS23337. 185p. NTIS, PC A09/MF A01.

Thesis.

The test procedure, Method of Testing, Rating and Estimating the Seasonal Performance of Central Air-Conditioners and Heat Pumps Operating in the Cooling Mode, has been analyzed. The analysis of the test procedure incorporated two main functions: (1) to determine the validity of the test procedure; and (2) to determine if there are other alternate methods of obtaining the same results with less testing burden. Data were collected from industry and analyzed for any significant trends. Certain conclusions are drawn about the energy efficiency ratios, degradation coefficients and seasonal energy efficiency ratios. An error analysis was performed on the test procedure to determine the approximate amount of error when using this procedure. A semi-empirical model assuming a first order system response was developed to determine the factors that affect the part-load and cooling-load factors. The corresponding transient characteristics are then determined in terms of a single time constant. A thermostat demand cycle is used to determine the relationship between on-time and cycle-time. Recommendations are made regarding an alternate method being used to determine the seasonal energy efficiency ratio.

30797 (EPRI-EM—1348(Vol.2)) **Assessment of the potential for heat recovery and load leveling on refrigeration systems. Volume 2. Detailed findings. Final report.** Merriam, R.L.; Lee, W.D.; Carr, J.E.; Boyce, S.E.; Bierenbaum, H.S. (Little (Arthur D.), Inc., Cambridge, MA (USA); Planning Research Corp./Systems Services Co., Cocoa Beach, FL (USA); Applied Energy Systems, Inc., Cape Canaveral, FL (USA)). Mar 1980. 299p. NTIS, PC A13/MF A01.

The potential energy savings from refrigerant heat recovery in the residential, commercial, and industrial sectors and its impact on electric utilities were assessed. It was concluded that the technology for heat recovery is well established in all sectors and in comparison with solar water heating equivalent energy savings can be achieved at a fraction of the cost. The critical barriers to implementation in the residential sector are primarily institutional in nature. In the absence of barriers, the potential market for heat recovery could be substantial, with an annual energy savings of 0.25 x 10^{15} Btu by 1990. The economic impacts on summer peaking electric utilities were found to be favorable in all regions in central air conditioner applications. Annual net cost savings to the utility were estimated to be $10 to $50 per residential application. In the commercial sector and food processing segment of the industry sector, refrigerant heat recovery could reduce total energy consumption by about 0.28 x 10^{15} Btu, with the major savings from applications in existing buildings. The major barriers to acceptance are lack of familiarity with the technology and uncertainty relating to future codes and standards. The potential impacts on summer peaking utilities were found to be favorable. Recommendations for removing the critical barriers in all three sectors are presented, including demonstrations of heat recovery technology.

30798 (NBSIR—79-1951) **Energy test method development for electric heat pump water heaters.** Wan, C.A. (National Engineering Lab. (NBS), Washington, DC (USA)). Jan 1980. Contract W-7405-ENG-26. 87p. NTIS, PC A05/MF A01.

Modifications are proposed for the current US Department of Energy test procedures for water heaters in order to make them applicable to electric heat pump water heaters. The modifications are in the areas of definitions and technical procedures. The latter include the test conditions, test procedures and measurements, and calculations. Reasons for making these modifications and laboratory test data are provided to support the modifications in the technical

procedures. The main modifications include: (1) lowering the water supply temperature from 70°F to 55°F, (2) lowering the tank thermostat setting from 160°F to 145°F to maintain the same 90°F temperature rise, (3) measuring the power input instead of using the nameplate rating as in the case for an electric water heater, and (4) measuring the recovery efficiency instead of calculating it by using the standby losses in the case for an electric water heater.

30799 (ORNL/Sub—7686/1) **Smoldering combustion hazards of thermal insulation materials.** Ohlemiller, T.J.; Rogers, F.E. (Princeton Univ., NJ (USA). Guggenheim Labs. for the Aerospace Propulsion Sciences). Jul 1980. Contract W-7405-ENG-26. 140p. NTIS, PC A07/MF A01.

Work on the smolder ignitability in cellulosic insulation and on thermal analytical characterization of the oxidation of this material is presented. Thermal analysis (TGA and DSC) shows that both retarded and unretarded cellulosic insulation oxidizes in two overall stages, both of which are exothermic. The second stage (oxidation of the char left as a residue of the first stage) is much more energetic on a unit mass basis than the first. However, kinetics and a sufficient exothermicity make the first stage responsible for ignition in most realistic circumstances. Existing smolder retardants such as boric acid have their major effect on the kinetics of the second oxidation stage and thus produce only a rather small (20°C) increase in smolder ignition temperature. Several simplified analogs of attic insulations have been tested to determine the variability of minimum smolder ignition temperature. These employed planar or tubular constant temperature heat sources in a thermal environment quite similar to a realistic attic application. Go/no-go tests provided the borderline (minimum) ignition temperature for each configuration. The wide range (150°C) of minimum ignition temperatures confirmed the predominant dependence of smolder ignition on heat flow geometry. Other factors (bulk density, retardants) produced much less effect on ignitability.

30800 **Energy efficiency in wood building construction. Proceedings.** Madison, WI; Forest Products Research Society (1977). 97p. (CONF-7711136—).

From Conference on energy efficiency in wood building construction; Chicago, IL, USA (8 Nov 1977).

A separate abstract was prepared for each of the 18 papers presented at the FPRS conference on energy efficiency in wood building contruction.

RESIDENTIAL BUILDINGS

REFER ALSO TO CITATION(S) 30478

30801 (DOE/AD/03871—T2) **Residential/commercial market for energy technologies.** Glesk, M.M. (Little (Arthur D.), Inc., Cambridge, MA (USA)). Aug 1979. Contract AC01-76PE03871. 81p. NTIS, PC A05/MF A01.

The residential/commercial market sector, particularly as it relates to energy technologies, is described. Buildings account for about 25% of the total energy consumed in the US. Market response to energy technologies is influenced by several considerations. Some considerations discussed are: industry characteristics; market sectors; energy-consumption characeristics; industry forecasts; and market influences. Market acceptance may be slow or nonexistent, the technology may have little impact on energy consumption, and redesign or modification may be necessary to overcome belatedly perceived market barriers. 7 figures, 20 tables.

30802 **Directory of room air conditioners which comply with November 3, 1977 standards but not with November 3, 1979 standards: sorted by voltage and capacity.** Sacramento, CA; California Energy Commission (1979). 27p. (NP—25020).

The California Energy Commission in 1976 adopted a two-step efficiency standard for room air conditioners. This directory lists only those models which comply with the standards which became effective on November 3, 1977 but do not comply with the standards which became effective on November 3, 1979. It includes information received by November 3, 1979. Another directory is available which lists those models which comply with the November 3, 1979 standards. Standards for room air conditioners appear in two different regulations. The Appliance Efficiency Regulations prohibit the sale and offering for sale of room air conditioners which do not meet the standards. The Energy Conservation Regulations for Residential and Nonresidential Buildings prohibit building departments from issuing permits for buildings which will contain room air conditioners that do not meet the standards.

30803 **Economic and energy effects of federal residential energy conservation programs.** Hirst, E.; Carney, J. (Oak Ridge National Lab., TN). pp 4-12 of Energy efficiency in wood building construction. Proceedings. Madison, WI; Forest Products Research Society (1977).

From Conference on energy efficiency in wood building construction; Chicago, IL, USA (8 Nov 1977).

The energy and direct economic effects of implementing various residential energy conservation programs are evaluated. These evaluations are conducted using a detailed engineering-economic model that simulates residential energy use on an annual basis from 1970 through 2000. These programs include several authorized by the 94th Congress and expanded upon by the present administration: appliance efficiency standards, thermal standards for construction of new residences, and weatherization of existing housing units. In addition to these Federal programs that are being (or will be) implemented in some form, we consider two additional measures to save energy: large fuel price increases and elimination of all market imperfections associated with the production and purchase of new equipment and homes. Altogether, nine different residential energy futures are considered. The highest projection, which assumes constant real fuel prices from 1976-2000, shows residential energy use growing from 16 QBtu in 1976 to 28 QBtu in 2000, with an average annual growth rate of 2.3%. The baseline, which assumes rising fuel prices, yields an energy use estimate of 24 QBtu in 2000. Implementing all the Federal programs listed above would cut energy use in 2000 by 11%, to 22 QBtU. Adopting these programs also reduces energy-related costs to households by $27 billion. Raising fuel prices by 50% after 1984 and eliminating all market imperfections yields essentially zero energy growth in the residential sector. However, the cost to households of higher fuel prices amounts to about $60 billion.

OFFICE BUILDINGS

30804 (SAI—026-79-699-LJ) **Development of minimum efficiency standards for large capacity air conditioners, and commercial water heaters, refrigerators, and freezers. Final report.** Merrill, P.S.; Rettberg, R.J.; Erickson, R.C.; Toor, J.S. (Science Applications, Inc., La Jolla, CA (USA)). May 1980. 292p. (P—400-80-041). California Energy Commission, Sacramento, CA.

The California Energy Resources Conservation and Development Commission has promulgated appliance energy efficiency standards and energy conservation standards for new construction with the objective of reducing energy consumption in the State of California. The following appliance categories are specifically addressed: large capacity air conditioners; commercial water heaters; and commercial refrigerators and freezers. The tasks that have been performed include: an energy use pattern study for the subject equipment; an examination of the size distribution of commercial air conditioning equipment; an examination of the different types of commercial air conditioning systems; an evaluation of the effectiveness of economizers in reducing commercial air conditioning system energy consumption in California; an examination of the effects of oversizing commercial air conditioners; a detailed study of supermarket refrigeration and air conditioning equipment; an evaluation of the economic feasibility of utilizing air conditioner waste heat to heat water; an assessment of the applicability of existing test procedures for small water heaters to large water heaters; and a brief investigation of the marketing and distribution systems for air conditioning and refrigeration equipment. Results of the efforts are described.

SCHOOL, MUNICIPAL AND OTHER PUBLIC BUILDINGS

REFER ALSO TO CITATION(S) 30801, 30804

30805 (P—400-80-009(Guidebook)) **Guidebook for schools and hospitals energy conservation program.** Brow, C. (California Energy Commission, Sacramento (USA)). Apr 1980. 127p. California Energy Commission, Sacramento.

The staff of the Schools and Hospitals Program at the California Energy Commission prepared the handbook for the owner or operator of a school, hospital, public care institution, or local government building. The California Energy Commission offers Federal matching fund grants to local governments, and public and private, nonprofit schools, hospitals, and public care institutions to study the feasibility of energy conservation projects for their buildings. Schools and hospitals are eligible for additional funds to make energy conserving changes to their buildings. The staff of the Commission provides assistance in applying for Program grants. Section II addresses the eligibility question in detail. Additional sections cover: how much money is available; how to apply for a grant; deadlines; technical assistance grants; energy conservation measure grants; what the Energy Commission Staff does with the application; allowable expenses; and record keeping and reporting requirements.

30806 (P—400-80-013) **List of certified energy auditors for the Federal Grant Program for schools and hospitals and for buildings owned by units of local government and public care institutions, and the Energy Conservation Assistance Act of 1979, a state loan program.** (California Energy Resources Conservation and Development Com-

mission, Sacramento (USA). Conservation Div.). 2 Apr 1980. 89p. California Energy Commission, Sacramento, CA.

A list of approximately 1500 persons who are certified energy auditors for the Federal Grant Program for schools and hospitals and for buildings owned by units of local government and public care institutions and the Energy Conservation Assistance Act of 1979, a state loan program, is presented. Information on the auditors' employer type and experience is included.

COMMERCIAL AND INDUSTRIAL BUILDINGS

REFER ALSO TO CITATION(S) 30780, 30801, 30804

30807 (DOE/TIC—10289) **Energy conservation in ice skating rinks.** Dietrich, B.K.; McAvoy, T.J. (Massachusetts Univ., Amherst (USA). Dept. of Chemical Engineering). 1980. 44p. NTIS, PC A03/MF A01.

An economic and energy analysis of ice rinks was made to examine the areas in which energy could be profitably conserved. The areas where new equipment could make a major reduction in energy use are: the use of waste heat for space heating, the installation of a low emissivity false ceiling to reduce radiant heat, the use of a load cycling controller to reduce refrigeration costs, and the installation of more efficient lighting systems. Changes in rink operating procedure that could cut energy use are: higher refrigerant temperatures, thinner ice, the use of colder resurfacing water, turning the compressors and pumps off at night, and reducing ventilation.

TRANSPORTATION

REFER ALSO TO CITATION(S) 30762

30808 (DOE/CS/00115—T1) **Transportation energy demand in alternative futures.** (SRI International, Menlo Park, CA (USA)). Jul 1978. Contract AT03-76CS50115. 87p. NTIS, PC A05/MF A01.

Four alternative-futures scenarios (high and moderate growth, changing values, depression, and recovery) were developed, including key assumptions about economic, demographic, and social conditions, and about resource availability. These scenarios are used to provide a context for projecting transportation energy demand, and to provide a framework for other kinds of long-range studies of transportation energy use and related factors. Energy-demand projections, from the present through the year 2025, were made for each major mode of transportation - automobiles and personal trucks, buses, railroads, commercial trucks, aviation, and water transportation. A set of long-range scenarios and baseline projections of transportation energy demand consistent with each scenario was provided. These baselines are intended to serve as starting points for future analyses of various transportation energy-conservation strategies. A common alternative-futures scenario framework for future work is provided. The scenarios developed can be elaborated for closer study of different projections of regional-transportation energy use; they can serve as the bases for inputs to more-elaborate forecasting models; or they can serve as starting points for developing other scenarios of the future.

30809 (DOE/EIA/CR—7405-01) **End use energy consumption data base: transportation sector.** Hooker, J.N.; Rose, A.B.; Greene, D.L. (Oak Ridge National Lab., TN (USA)). Feb 1980. Contract W-7405-ENG-26. 426p. NTIS, PC A19/MF A01.

The transportation fuel and energy use estimates developed a Oak Ridge National Laboratory (ORNL) for the End Use Energy Consumption Data Base are documented. The total data base contains estimates of energy use in the United States broken down into many categories within all sectors of the economy: agriculture, mining, construction, manufacturing, commerce, the household, electric utilities, and transportation. The transportation data provided by ORNL generally cover each of the 10 years from 1967 through 1976 (occasionally 1977 and 1978), with omissions in some models. The estimtes are broken down by mode of transport, fuel, region and State, sector of the economy providing transportation, and by the use to which it is put, and, in the case of automobile and bus travel, by the income of the traveler. Fuel types include natural gas, motor and aviation gasoline, residual and diesel oil, liuqefied propane, liquefied butane, and naphtha- and kerosene-type jet engine fuels. Electricity use is also estimated. The mode, fuel, sector, and use categories themselves subsume one, two, or three levels of subcategories, resulting in a very detailed categorization and definitive accounting.

AIR AND AEROSPACE

30810 (DOE/CS/2184—2) **Examination of commercial aviation operational energy conservation strategies.** (Aerospace Corp., El Segundo, CA (USA). Eastern Technical Div.). Oct 1978. Contract AC03-78CS52184. 321p. NTIS, PC A14/MF A01.

Forty-seven fuel conservation strategies are identified for commercial aviation and the fuel saving potential, costs, constraints, and current implementation levels of these options are examined. This assessment is based on a comprehensive review of published data and discussions with representatives from industry and government. Analyses were performed to quantify the fuel saving potential of each option, and to assess the fuel savings achieved to date by the airline industry. Those options requiring further government support for option implementation were identified, rated, and ranked in accordance with a rating methodology developed in the study. Finally, recommendations are made for future government efforts in the area of fuel conservation in commercial aviation.

LAND AND ROADWAY

30811 (LCD—78-245) **Replacing government sedans yearly would result in fuel and cost savings.** (General Accounting Office, Washington, DC (USA)). 8 May 1979. 36p. General Accounting Office, Washington, DC.

Commercial rental companies are ahead of the Government in recognizing and taking advantage of the economics of a 1-year replacement cycle for rental sedans. To GAO's knowledge, the General Services Administration is the only large organization that replaces its rental fleet on a 6-year cycle. GAO has determined that, by adhering to this replacement standard, General Services (1) incurs unnecessary maintenance costs, (2) does not take advantage of optimal resale value, (3) is not providing the most cost-efficient vehicle service, and (4) is not taking full advantage of opportunities to conserve fuel. By converting to a 1-year replacement cycle, General Services could save about $9.1 million a year on lower-maintenance costs and higher-resale values. In addition, about 4.7 million gallons of gasoline a year - worth about $3.6 million - could be saved.

INDUSTRY AND AGRICULTURE

REFER ALSO TO CITATION(S) 30525, 30762

30812 (CONF-800381—) **Annual general meeting and seminar on (I) Utilization of agricultural residues for paper and board; (II) Capacity utilization and energy conservation.** (Tata Energy Research Inst., Bombay (India)). 1980. 67p. NTIS (US Sales Only), PC A04/MF A01.

From Annual general meeting and seminar on utilization of agricultural residues for paper and board; New Delhi, India (29 Mar 1980).

Six papers were presented at the meeting. A separate abstract was prepared for each paper. (LCL)

30813 (DOE/CS—0173) **Agriculture and Food Processes Branch program summary document.** (Department of Energy, Washington, DC (USA). Assistant Secretary for Conservation and Solar Energy). Jun 1980. 88p. NTIS, PC A05/MF A01.

The work of the Agriculture and Food Processes Branch within the US DOE's Office of Industrial Programs is discussed and reviewed. The Branch is responsible for assisting the food and agricultural sectors of the economy in increasing their energy efficiency by cost sharing with industry the development and demonstration of technologies industry by itself would not develop because of a greater than normal risk factor, but have significant energy conservation benefits. This task is made more difficult by the diversity of agriculture and the food industry. The focus of the program is now on the development and demonstration of energy conservation technology in high energy use industry sectors and agricultural functions (e.g., sugar processing, meat processing, irrigation, and crop drying, high energy use functions common to many sectors of the food industry (e.g., refrigeration, drying, and evaporation), and innovative concepts (e.g., energy integrated farm systems. Specific projects within the program are summarized. (LCL)

ENERGY SOURCES

REFER ALSO TO CITATION(S) 30164, 30361, 30780

EQUIPMENT AND PROCESSES

REFER ALSO TO CITATION(S) 30186, 31023, 31024

30814 (DOE/CS/5172—) **Western European energy conservation technologies for evaporators.** (Centec Consultants, Inc., Fort Lauderdale, FL (USA)). Jun 1980. Contract EM-78-C-01-5172. 31p. NTIS, PC A03/MF A01.

The status of evaporation technologies in Western Europe are presented and those methods and technologies which have been

proven and can be applied by US manufacturers are identified. The energy savings and performance of these technologies in industrial plants are presented to provide additional incentives for US manufacturers to reduce energy consumption by improving the operating costs of evaporation. Advanced technologies for installations that exhibit maximum economy based on present levels of technology in the chemical, pulp and paper, and food industries are highlighted.

WASTE HEAT RECOVERY AND UTILIZATION

REFER ALSO TO CITATION(S) 30814

30815 (DOE/CS/40167—T1) **Demonstration of energy conservation for multi-deck board dryers. Phase I. Final report.** (Johns-Manville Corp., Denver, CO (USA)). 8 Feb 1980. Contract AC03-78CS40167. 123p. NTIS, PC A05/MF A01.

A study was made to determine the feasibility of recovery and reuse of low level heat from the exhausts of multi-deck dryers used to dry boards in the building materials industry. There are approximately 1000 dryers of this type in the US which typicaly exhaust to the atmosphere with no heat recovery. The feasibility study was made at the roof insulation board plant operated by Johns-Manville at Rockdale, Illinois. The 461 foot-long dryer has a nominal heat input of 133 million Btu/h. Pilot scale tests and analyses show that the following types of heat exchange equipment are feasible: indirect contact air-to-air heat exchangers for preheating combustion air for the dryer furnaces; direct contact air-to-water heat exchangers using water sprays to heat process water; and indirect contact air-to-liquid heat exchangers to heat recirculating liquid in a plant building heating system. All three of these types are recommended for design and installation at the Rockdale plant. The estimated installed cost for these systems at the Rockdale plant is $565,000 (1979 dollars). Annual heat recovery of 186,000 million Btu is projected with a value of $545,000 using gas costs of $3.00 per million Btu. Payback based on a discounted cash flow analysis using ten year depreciation is about two years. The preparation of detailed engineering design and cost estimates followed by installation and evaluation is recommended.

30816 (DOE/ET/15350—T1) **Design study of a two-phase turbine bottoming cycle.** (Biphase Energy Systems, Santa Monica, CA (USA)). 15 Jun 1979. Contract EY-76-C-03-1207. 133p. NTIS, PC A07/MF A01.

The use of a biphase turbine system to recover waste heat from diesel engines was examined and found to have many favorable attributes. Among these were low rpm, high torque, low heat exchanger cost and simplicity. Several candidate working fluid combinations were tested at temperatures of interest. The contact heat exchanger concept was substantiated by large scale experiment. The program includes subscale tests of key hardware components of a biphase turbine bottoming system. These are the two-phase nozzle, two-phase turbine and direct contact heat exchanger. A comprehensive cost analysis was completed. A three-year program leading to a full-size system field demonstration has been planned. The first year of this program is complete and reported herein, and effort has started on the second year program.

30817 (WRRC-PUB—65) **Evaluation of proposed man-made ponds for food production to recover values in waste heat and solid organic sludges.** Zahradnik, J.W.; Turner, L.S.; Levine, H.L.; Tucker, C. (Massachusetts Univ., Amherst (USA). Water Resources Research Center). Mar 1976. 61p. Univ. of Massachusetts, Amherst, MA.

A system analysis was performed to determine the technical and economic feasibility of simultaneously using power plant waste heat and sewage sludges to produce food in an aquatic environment. Aquatic environment temperatures were calculated. The possibilities for growing rice, fish, and plankton were examined. It was concluded such a combined waste heat-sewage sludge utilization system is technically feasible but not currently economically feasible. (LCL)

INDUSTRIAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 30055, 30056, 30085, 30131, 30132, 30133, 30134, 30407

30818 (DOE/ET/10415—39) **Development of potential uses for the residue from fluidized bed combustion processes. Quarterly Technical Progress report, December 1979-February 1980.** Minnick, L.J. (Minnick (L.J.), Inc., Plymouth Meeting, PA (USA)). 1980. Contract AC21-77-ET10415. 35p. NTIS, PC A03/MF A01.

The free lime content of the spent bed residue sample from the Georgetown AFB boiler has higher than average free lime, total lime, and magnesium content, and smaller than normal proportion of silica, aluminum, and iron, when compared to previously analyzed spent bed residue samples from other sources. Investigation of the use of spent bed residue as a component of blended cement revealed expansive properties which make such use for conventional concrete construction purposes somewhat questionable. However, these blended cement mixes expand in a predictable manner, show no cracking, and do increase in strength over time, suggesting their application as an expansive concrete for pressure grouting and stowage for mine backfilling. AFB residue/fly ash blends mixed with clay-silt soil exhibit strength development and volume stability characteristics that further recommend the application of such blends as a soil grouting medium. The information and experience obtained in the masonry block demonstration permit an accurate design of mix formulations using AFB residue with conventional block making equipment to meet current ASTM specifications for masonry block. Pre-treatment is necessary in order to develop high-carbon AFB fly ash for use in water treatment applications.

MUNICIPALITIES AND COMMUNITY SYSTEMS

30819 (EUR—6740-EN) **Energy: diesel heat pump for district heating plants and for the heating of large housing blocks.** Petersen, B. (Commission of the European Communities, Luxembourg). 1980. 219p. NTIS (US Sales Only), PC A10/MF A01.

The technical, economic, and environmental aspects of large diesel-driven heat pump plants for district heating or very large building heating was investigated. Possible heat sources, e.g., air, ground, and surface and waste waters, geothermal and solar sources were studied and the operation of existing district heating plants was analyzed. The possibility of using other prime movers such as gas turbines, coal-fired steam turbines and electric motors was examined for cost and efficienty. It was found that technically it is possible to construct diesel driven heat pumps in the 5 to 20 MW size range, yielding energy savings of typical 50%. At present energy prices such plants are profitable. The investigation of possible heat sources for such large heat pump gave the result that several water sources, such as sewage water, ground water, sea water, river water, and lake water could be used without problems. The use of low temperature geothermal heat looks favorable, but has to be investigated further. The diesel engine is the most economic and effient prime mover for the heat pump, but prime movers like gas engines, coal fired steam turbines and electric motor can be used, which gives a flexibility with respect to the primary energy supplies. Gas engines and electrically driven heat pumps were found to be the best solutions for small towns up to 2500 inhabitants, diesel and dual fuel engine driven heat pumps for towns with 2500 to 20,000 inhabitants, and combined heat and power production on the basis of coal (and nuclear) for large towns. (LCL)

MUNICIPAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 30360, 30361, 30783, 30817, 31203

30820 (DOE/R5/10105—1) **DOE feasibility report on Lake Calumet area refuse-to-energy facility.** (National Energy Corp., Glen Ellyn, IL (USA)). 18 Jun 1980. Contract FG02-79R510105. 241p. NTIS, PC A11/MF A01.

Site analyses and literature reviews were conducted to determine the feasibility of building an energy-producing municipal waste incinerator at Calumet Lake, Illinois. The amount of burnable waste produced within 5 and 10 miles of the near-Chicago site, the composition and heating value of this solid waste, and the air pollution impacts of waste incineration were determined, and the economic value of recovered material or of steam and electricity produced at the plant are discussed. It is concluded that there is sufficient refuse in the area to support a refuse processing center, that increasng landfill costs make such a center economically attractive, and that the Btu content of the refuse is adequate to produce steam for heat and power use. Replacing existing oil-fired power plants with this facility would result in an 88% reduction in current pollutant emission levels. There is a ready market for steam that could be produced. It is recommended that steps be taken to implement the establishment of the proposed waste processing center. (LCL)

30821 (ISU-ERI-AMES—79103) **Solid waste to energy conference: the Ames Experience.** (Iowa State Univ. of Science and Technology, Ames (USA). Engineering Research Inst.). 1978. 182p. (CONF-7803128—). $30.00.

From Solid waste to energy conference - the Ames experience; Ames, IA, USA (15 Mar 1978).

Twelve papers were presented at the meeting. A separate abstract was prepared for each paper. (LCL)

30822 (ISU-ERI-AMES—79103, pp 3-6) **Ames Solid Waste Recovery Project.** Peterson, P.W. 1978.

From Solid waste to energy conference - the Ames experience; Ames, IA, USA (15 Mar 1978).

The organization and contract responsibilities for the Ames Solid Waste Recovery Project, and the funding, and present status of the project are discussed briefly. (LCL)

30823 (ISU-ERI-AMES—79103, pp 7-14) **Overall resource recovery problems: economics, energy, environment.** Jakobson, K. (Environmental Protection Agency, Washington, DC). 1978.

From Solid waste to energy conference - the Ames experience; Ames, IA, USA (15 Mar 1978).

The economic, energy, and environmental aspects of resource recovery systems are examined and interrelated. It is concluded that although the US has been slow in developing and establishing such systems, the economics of increasing scarcity of land for solid waste disposal and rising energy costs will promote resource recovery from wastes. (LCL)

30824 (ISU-ERI-AMES—79103, pp 15-18) **Biomedical and environmental aspects of solid waste energy systems.** Walters, D.K. (Dept. of Energy, Washington, DC). 1978.

From Solid waste to energy conference - the Ames experience; Ames, IA, USA (15 Mar 1978).

The US DOE program of recovering resources from municipal solid wastes is discussed with emphasis on federal legislation which has authorized and funded the program. (LCL)

30825 (ISU-ERI-AMES—79103, pp 19-24) **Ames as a primary component of the federal waste-to-energy research effort.** Olexsey, R.A.; Wiles, C.C. (Environmental Protection Agency, Cincinnati, OH). 1978.

From Solid waste to energy conference - the Ames experience; Ames, IA, USA (15 Mar 1978).

The involvement of the US EPA in evaluating the environmental effects, boiler performance and corrosion when burning refuse-derived fuels, and the economics of the Ames Resource Recovery Facility is described. (LCL)

30826 (ISU-ERI-AMES—79103, pp 25-40) **Architectural and engineering approach to a systems study of solid waste recovery.** Hazell, W.J. (Henningson, Durham, and Richardson, Omaha, NE). 1978.

From Solid waste to energy conference - the Ames experience; Ames, IA, USA (15 Mar 1978).

An engineering method is presented for performing a feasibility study of a resource recovery proposal. Such a study would include assembling data on plant operation and economics, environmental effects, research, financing alternatives, legal aspects, program implementation and project management. (LCL)

30827 (ISU-ERI-AMES—79103, pp 41-48) **Development of the Ames System: incentives to solve a problem.** Sprenkel, T.V. 1978.

From Solid waste to energy conference - the Ames experience; Ames, IA, USA (15 Mar 1978).

The economics of processing municipal waste to produce refuse-derived fuel for power generating plants is discussed in reference to experience at the Ames, Iowa Resource Recovery Facility. This experience showed that minimization of facility down-time has a major impact on net per-ton costs; that costs must be minimized in order to provide utilities with incentives for using the refuse-derived fuel; some costs can be controlled by improved management techniques and tools; and, although resource recovery operations to produce power plant fuels have been expensive and may continue to be expensive, refuse-derived fuels need to be recognized in our national energy policy as a major source of supplementary fuel to meet our energy needs. (LCL)

30828 (ISU-ERI-AMES—79103, pp 49-60) **Ames system and its operations to date.** Chantland, A.O. 1978.

From Solid waste to energy conference - the Ames experience; Ames, IA, USA (15 Mar 1978).

The purpose of this paper is to describe the Ames Solid Waste Recovery System, the equipment involved, and what takes place during the operations and modifications that have been made or are in the process of being completed in the near future.

30829 (ISU-ERI-AMES—79103, pp 61-70) **Reseach project objectives and methods.** Joensen, A.W. 1978.

From Solid waste to energy conference - the Ames experience; Ames, IA, USA (15 Mar 1978).

Research activities at Iowa State University conducted in connection with the Ames Solid Waste Resource Recovery System are outlined. These include research on emissions from refuse-fueled power plant, process plant subsystems, and system economics. (LCL)

30830 (ISU-ERI-AMES—79103, pp 71-86) **Economics of solid waste resource recovery: analysis of the Ames System.** Adams, S.K. 1978.

From Solid waste to energy conference - the Ames experience; Ames, IA, USA (15 Mar 1978).

The economics of the Ames Solid Waste Resource Recovery System is discussed in terms of capital, operating, and maintenance costs and revenues from customers, refuse-derived fuel, electric power generated, and recovered materials. (LCL)

30831 (ISU-ERI-AMES—79103, pp 87-104) **Process plant flow stream characterization.** Even, J.C. Jr. 1978.

From Solid waste to energy conference - the Ames experience; Ames, IA, USA (15 Mar 1978).

Procedures used to sample and to analyze the process flow stream in the Ames Solid Waste Resource Recovery System are discussed. Each week four sets of analyses of the flow stream are performed to determine density, particle size distribution, moisture content, heating value, composition, i.e., wood, paper, plastic, metal, and chemical analysis. This research will provide valuable dataon the materials handled by and material output from the waste processing plant. (LCL)

30832 (ISU-ERI-AMES—79103, pp 105-134) **Emissions from Stoker-fired boilers using coal-RDF mixtures.** Hall, J.L.; Joensen, A.W.; Severns, G.A.; Van Meter, D.B.; Shanks, H. 1978.

From Solid waste to energy conference - the Ames experience; Ames, IA, USA (15 Mar 1978).

Results are presented of the emission evaluations of stoker-fired boilers operating at the Ames, Iowa, power plant while burning mixtures of refuse-derived fuel (RDF) and coal. The facilities, test design and sampling procedure are summarized and emission results are given. Emissions of uncontrolled particulates, chlorides, trace elements of copper, lead and zinc all increase consistently with increases in RDF. Emissions of sulfur oxides and nitrogen oxides decrease with increases in RDF. No discernible trends, within the data scatter, were noted concerning formaldehyde, hydrocarbons C_1 and C_6, and many of the 17 different trace elements scanned during these experiments. Combustible and noncombustible characteristics of the boiler grate ash became more like the corresponding flyash characteristics as the amount of RDF was increased. Further studies are still in progress at the Ames facility.

30833 (ISU-ERI-AMES—79103, pp 135-146) **Analysis of power plant emissions.** Shanks, H.R. 1978.

From Solid waste to energy conference - the Ames experience; Ames, IA, USA (15 Mar 1978).

Some of the properties of the refuse-derived fuel (RDF) and the organics in the stack gases from the Ames Resource Recovey Plant are summarized, and some oveall statements are made about the environmental effects of burning RDF with coal.

EDUCATION AND PUBLIC RELATIONS

30834 (DOE/CA—005) **Guide for the preparation of proposals for the Pre-Freshman Engineering Program: PREP-1981, (for minorities and women).** (Department of Energy, Washington, DC (USA). Office of Consumer Affairs). Aug 1980. 14p. NTIS, PC A02/MF A01.

The Pre-Freshman Engineering Program (PREP) for minorities and women (formerly PREFACE) will provide funds to colleges and universities for projects aimed at seeking out minority group individuals and women during junior high school and high school years (7th grade through the summer preceding matriculation in college) and providing them with enrichment experiences. Preparation and submission of proposals, evaluation and selection of proposals for support, and preparation of the final report are described.

30835 (DOE/CA—0002) **Activities of the U.S. Department of Energy in education. Annual status report, FY 1979.** (Department of Energy, Washington, DC (USA)). Apr 1980. 16p. NTIS, PC A02/MF A01.

The energy-related education activities administered in FY 1979 by DOE are described: projections for FY 1980 are also given. This document provides assistance for DOE program managers who wish to use the educational process in their operations, and it provides guidance and information to educators and the general public about DOE energy-related education activities. The education activities are classified as energy information (curriculum packages, studies, workshops and forums conferences, other materials), energy skills development, institutional resource enhancement, and other activities. A chart gives the category of activity, type of audience, and type of services provided. (RWR)

ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

INTERNAL COMBUSTION ENGINES

TURBINE

30836 (CONF-800419—4) **Third interim report on status of gas turbine transit bus demonstration program.** (Booz, Allen and Hamilton, Inc., Bethesda, MD (USA). Transportation Consulting Div.). 15 Apr 1980. 15p. NTIS, PC A02/MF A01.

From 5. symposium on automotive propulsion systems; Dearborn, MI, USA (14 Apr 1980).

Progress in a program for demonstrating the use of gas turbines in city buses is reported. Five prototype gas turbine engines, Model GT-40404, manufactured by the Detroit Diesel Allison Division of General Motors Corporation, are being integrated into five RTS-II model transit coaches, manufactured by General Motors Corporation and supplied by the Mass Transit Administration (MTA) of Baltimore, Maryland. They will be acceptance tested at the Transportation Research Center proving grounds in Ohio, where one gas turbine coach will also be performance and mileage tested against a diesel RTS-II coach. The first diesel-to-turbine engine conversion is done. The second conversion is almost completed. The demonstration plan for the 5 gas turbine coaches has been finalized. (LCL)

ELECTRIC-POWERED SYSTEMS

REFER ALSO TO CITATION(S) 30739

30837 (CONS—5160-T1) **Insulation development for high-temperature batteries for electric vehicle application. Final report.** (Union Carbide Corp., Tonawanda, NY (USA). Linde Div.). Dec 1979. Contract EM-78-C-01-5160. 114p. NTIS, PC A06/MF A01.

The objective of this contract is to develop and demonstrate a high performance, vacuum insulation which is capable of withstanding 15 psi plus battery loading with low compression operating in the 660 to 840°F range. The developed insulation would allow construction of rectangular, lightweight and low-cost, vacuum-insulated enclosures for electric vehicles using Na/S or Li/MS batteries. The goals of the program are to develop a vacuum insulation with the following properties: thermal conductivity 140 x 10^{-5} Btu/h-ft°F, density, 18 lbs/ft^3 and compression 10% from 0 to 15 psi load. A new milestone in high-temperature, load-bearing, preformed insulation was achieved. The two insulation systems demonstrated to-date have exceeded the goals of the program. Pegged Multi-Foil system has a measured conductivity of 100 x 10^{-5} Btu/h-ft°F between 840 and 75°F, density 11 lbs/ft^3 and compression of 10%. The second system which exceeded the goals of the program is a Linde Multi-Foil inslation with discrete load-carrying support areas. It has a measured thermal conductivity of 95 x 10^{-5} Btu/h-ft°F, a density of 15 lbs/ft^3 and a compression of 21%. A third inslation is a continuous support, load-bearing board system. Although the thermal conductivity and density are above the goal of the program, the system is very practical and may be used in specialized applications; i.e., forklift trucks. The best load-bearing board insulation system developed to-date has a conductivity of 224 x 10^{-5} Btu/hr-ft°F, a density of 22 lbs/ft^3 and a compression of 7%. It is believed that the new insulation systems need further development in order to establish their long-term stability, handleability and cost-effective production.

30838 (COO—2566-53-T1) **Ford/DOE sodium-sulfur battery electric vehicle development and demonstration. Phase I-1. Final report.** (Ford Motor Co., Dearborn, MI (USA)). 1979. Contract EY-76-C-02-2566. 184p. NTIS, PC A09/MF A01.

The results of Phase I-A analyses and design studies are presented. The objective of the Phase I-A effort was to evaluate the sodium-sulfur battery, in an existing conventional production automobile, as a potential power source for an electric vehicle. The Phase I-A work was divided into five (5) major sub-tasks as follows: vehicle specification sub-task; NaS battery packaging study sub-task; vehicle packaging layout sub-task; electrical system study sub-task; and system study sub-tasks covering performance and economy projections, powertrain and vehicle safety issues and thermal studies. The major results of the sodium-sulfur battery powered electric vehicle study program are: the Fiesta was chosen to be the production vehicle which would be modified into a 2-passenger, electric test bed vehicle powered by a NaS battery; the vehicle mission was defined to be a 2-passenger urban/suburban commuter vehicle capable of at least 100 miles range over the CVS driving cycle and a wide open throttle capability of 0 to 50 mph in 14 seconds, or less; powertrain component specifications were defined; powertrain control strategy has been selected; and a suitable test bed vehicle package scheme has been developed.

30839 (DOE/NASA/1004—9) **Impact of propulsion system R and D on electric vehicle performance and cost.** Schwartz, H.J.; Gordan, A.L. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1980. Contract A101-77CS51044. 17p. (NASA-TM—81548). NTIS, PC A02/MF A01.

The propulsion subsystem (motor, motor controller, transmission, and differential but excluding the battery) is a major factor in the purchase price and cost of ownership of an electric vehicle. Three propulsion system characteristics: efficiency, weight, and manufacturing cost influence price and operating cost as seen by the consumer. a study has been made of the relative impact of the three factors on the cost of buying and operating a traffic-compatible electric vehicle. The study concludes that propulsion system technology advances can result in a major reduction in the sticker price of an electric vehicle and a smaller, but significant, reduction in overall cost of ownership. The paper discusses the assumptions, methodology, and results of the study.

30840 (DOE/NASA/1011—31) **Preliminary results of steady state characterization of the near term electric vehicle breadboard propulsion system.** Sargent, N.B. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). Jul 1980. Contract A101-76CS51011. 11p. (NASA-TM—81546). NTIS, PC A02/MF A01.

Steady state test results on a breadboard version of the General Electric Near Term Electric Vehicle (ETV-1) are presented. The breadboard was built using exact duplicate vehicle propulsion system components with few exceptions. Full instrumentation was provided to measure individual component efficiencies. Tests were conducted on a 50 hp dynamometer in the NASA Lewis Research Center Road Load Simulator Facility.

30841 (UCRL—52894) **Aluminum-air power-cell system design: mass and enthalpy balance.** Homsy, R.V. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 19 Dec 1979. Contract W-7405-ENG-48. 93p. NTIS, PC A05/MF A01.

In designing an aluminum-air power cell for electric vehicle propulsion, a mass and enthalpy balance was performed on the galvanic cell stack and on each of the components required to support its operation. A computer program is presented, which calculates steady-state temperature, flow rate, and composition of all streams in the integrated power-cell system. The steady-state performance of the system was determined over a representative range of four operating variables: current density, air-flow rate, environmental temperature, and crystallizer temperature. The power-cell system condenses water required for the operation of the cell from the exhaust of the air-cathode stream; the air-flow rate required for this operation is determined for a range of environmental temperatures. It is concluded that a vehicular power cell can operate satisfactorily at a temperature of 60°C over extremes of driving cycles. It is also concluded that the reaction product may be stored most effectively on board the vehicle in the form of a water-washed, drained solid containing about 14% water.

ALTERNATIVE FUELS

30842 (DOE/CS/56051—2) **Potential sources of non-petroleum based alcohols for vehicular fleet testing.** (Mueller Associates, Inc., Baltimore, MD (USA)). Oct 1979. Contract EX-76-C-01-2098. 23p. NTIS, PC A02/MF A01.

The quantity of alcohol required to supply all of the US Department of Energy's vehicular fleet test fuel needs during the period fiscal year 1980 through 1982 could reach on the order of 1.5 and 1.6 million gallons per year of 200 proof ethanol and fuel-grade methanol, respectively. During the time frame of fiscal year 1982 through 1987, vehicular fleet testing fuel needs could approach 8 and 10 million gallons per year of ethanol and methanol, respectively. In terms of supply, all of the ethanol fleet test fuel requirements can be satisfied by domestic fermentation ethanol from non-petroleum/non-natural gas resources. Initially, the major ethanol fermentation firms are potentially capable of supplying the necessary quantity of ethanol. As the test project progresses and fleet size expands, the outlook for ethanol supply from the major firms as well as from other private sources, both existing and planned, is very promising. This supply outlook could be altered significantly if an expanding Gasohol market demands a major portion of the available ethanol production. It is in the Federal Government's best interest to arrange for ethanol supply agreements as soon as possible so that fleet test volume requirements can be assured. The supply situation for methanol from non-petroleum/non-natural gas resources is not very promising. It appears that methanol produced from coal or biomass will not be available before 1985 at the earliest, assuming that a decision to construct a sizeable plant is made immediately. As such, fuel grade methanol for use in the reliability fleet test project will most likely have to be obtained from the existing petroleum/natural gas-based methanol market. This market is currently operating at a level below maximum capacity and several older mothballed plants can be reactivated if the economic situation warrants.

MATERIALS

METALS AND ALLOYS

REFER ALSO TO CITATION(S) 30103, 30162, 30163

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 30691, 30860, 30888, 30904, 30922

30843 Method for cleaning bomb-reduced uranium derbies. Banker, J.G.; Wigginton, H.L.; Beck, D.E.; Holcombe, C.E. US Patent Application 068,358. [nd]. 10p.

The concentration of carbon in uranium metal ingots induction cast from derbies prepared by the bomb-reduction of uranium tetrafluoride in the presence of magnesium is effectively reduced to less than 100 ppM by removing residual magnesium fluoride from the surface of the derbies prior to casting. This magnesium fluoride is removed from the derbies by immersing them in an alkali metal salt bath which reacts with and decomposes the magnesium fluoride. A water quenching operation followed by a warm nitric acid bath and a water rinse removes the residual salt and reaction products from the derbies.

30844 (INEL-tr—50) **Pig-iron processes: Sweden's research and development needs.** Edstrom, J.O. (Styrelsen foer Teknisk Utveckling, Stockholm (Sweden)). [nd]. Translation of STU-Report No. 74-1977, pp 3-9. 7p. NTIS, PC A02/MF A01.

Current research and development regarding pig iron production processes were studied. Steps for future research are described. (FS)

30845 (BDX—613-2275) **Electrochemical form grinding. Fnal report.** Stiles, R.W. (Bendix Corp., Kansas City, MO (USA)). Jun 1980. Contract AC04-76DP00613. 23p. NTIS, PC A02/MF A01.

Electrochemical form grinding cutting tests were performed on 25 17-4 PH stainless steel bars by a copper resin aluminum oxide wheel formed from a diamond form block. Tests investigated methods of dressing a form into a grinding wheel, nozzle design, optimum machine settings, and tolerance capabilities. The electrolyte was distributed evenly onto the wheel by a form-fitting nozzle, and a minimum of two passes, rough and finish, were made because of current density variations throughout the cut. Tolerance held on the form test samples was +- 0.12 mm on the contour, with an average 0.12 mm overcut.

30846 (BDX—613-2442) **Effects of xenon cover gas in CO_2 laser welding.** Hendrix, T.L. (Bendix Corp., Kansas City, MO (USA)). Jul 1980. Contract AC04-76DP00613. 31p. NTIS, PC A03/MF A01.

Weld spatter in CO_2 laser welding is detrimental to miniature components. The effects of using xenon gas as an inert laser welding atmosphere to reduce weld spatter are discussed. The laser plume characteristics, weld penetration, and weld spatter are evaluated.

30847 (BDX—613-2444) **Ultrasonic seam welding. Final report.** Darner, G.S. (Bendix Corp., Kansas City, MO (USA)). Jun 1980. Contract AC04-76DP00613. 22p. NTIS, PC A02/MF A01.

Ultrasonic seam welding has been evaluated for making continuous seam welds on aluminum and copper-foil conductors. A seam welding system has been designed and fabricated, weldable material combinations have been identified, and the process parameters for welding materials applicable to flat cable production have been established.

30848 (BDX—613-2447) **Resistance spot welding of Ti-6A1-4V alloy.** Jarboe, D.M. (Bendix Corp., Kansas City, MO (USA)). Jun 1980. Contract AC04-76DP00613. 27p. NTIS, PC A03/MF A01.

The effects of weld power, electrode force, electrode tip radius, and elapsed time between cleaning and welding on resistance spot welds in Ti-6Al-4V alloy were evaluated. The alloy is weldable by this technique, and a wide latitude can be taken in processing variables.

30849 (HEDL-SA—1894-FP) **Development of a modified diffusion type carbon activity meter for liquid sodium.** Barton, G.B.; Cook, W.V.; McCauley, D.L. (Hanford Engineering Development Lab., Richland, WA (USA)). Jan 1980. Contract AC14-76FF02170. 10p. (CONF-800401—15). NTIS, PC A02/MF A01.

From 2. international conference of liquid metal technology for energy systems; Richland, WA, USA (20 Apr 1980).

A high sensitivity automated carbon activity meter has been developed by combining elements of technology used in other instruments. The basic principle is the diffusion of carbon through an iron membrane driven by the concentration gradient between the sodium being measured and the sweep gas. The membrane used is similar to that used by Harwell workers, i.e., a coil of small diameter iron tubing with an oxide coating on the inner surface. A sweep gas of helium is used to pick up the carbon oxides generated by the reaction of carbon and iron oxide. The carbon oxides are converted to carbon dioxide in a copper oxide bed and measured with a gas chromatograph employing a helium ionization detector. This measuring system has an excellent signal-to-noise ratio and requires fewer gases than the flame ionization detector usually employed. The concentration of CO_2 in the sweep gas was in the range of 0.2 to 2 ppM when measuring carbon activity in a stainless steel system.

30850 (LA-UR—80-1068) **Plasma phenomena during Nd-YAG laser welding.** Casey, H. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 5p. (CONF-800922—2). NTIS, PC A02/MF A01.

From 6. international conference on gas discharges and their applications; Edinburgh, UK (8 Sep 1980).

Portions of document are illegible.

The plasma plume formed during welding with a pulsed Nd-YAG laser attenuates the laser radiation and directly affects weld penetration. The attenuation is proportional to the intensity of the plasma and, therefore, increases with increase in the gas pressure of the working environment. As the intensity of the plasma increases, heat radiation from the plasma becomes a significant factor contributing to the size of the melt zone.

30851 (RDT-M—2-3T(Amend.)) **Carbon and alloy steel welding fittings (ASME SA-234 with additional requirements).** (Department of Energy, Washington, DC (USA). Office of Nuclear Energy Programs). 11 Jul 1980. 8p. RSO.

Reference to ASME Section III, NB-2556 is no longer applicable. Reference changed to applicable material specification ASME SA-652 which now invokes ASME Section V and states evaluation requirements.

30852 (RDT-M—2-5T(Amend.)) **Austenitic stainless steel welding fittings (ASME SA-403 with additional requirements).** (Department of Energy, Washington, DC (USA). Office of Nuclear Energy Programs). 11 Jul 1980. 7p. RSO.

This standard supersedes the August 1979 issue on RDT M 2-5T and incorporates changes to make the standard consistent with the 1977 edition of the ASME Code, Section II, through the Winter 1979 Addenda.

30853 (SAND—78-1975) **Thermodesorption of gases from various vacuum materials.** Beavis, L.C. (Sandia Labs., Albuquerque, NM (USA)). Jun 1979. Contract AC04-76DP00789. 45p. NTIS, PC A03/MF A01.

A number of materials are commonly used as vacuum system walls. The desorption of gases from these materials may contribute significantly to the internal pressure of an unpumped device or to the gas load which a pump must handle in a dynamic system. This report describes the thermodesorption measurements made on a number of metals (molybdenum, nickel, Kovar alloy, copper, copper-2% beryllium alloy) and two insulators (molybdenum sealing glass ceramic and high alumina ceramic). All of the materials after typical cleaning and air exposure contain considerable gas. With a long 400° to 500° vacuum bake, however, all can be cleaned sufficiently so that they will not contribute appreciable gas to their surrounding when vacuum stored at room temperature for many years. Most materials display desorption kinetics which are first order (a single bond or trap energy must be overcome for desorption). It appears that the desorption of CO from Kovar is rate limited by carbon diffusion ($D_0 \simeq .4$ cm²/s and E/sub d/ ≃ 27,000 cal/mol). The desorption of hydrogen from glass ceramic also appears to be diffusion rate limited ($D_0 \simeq 1 \times 10^{-3}$ cm²/s and E/sub d/ ≃ 11,000 cal/mol). Carbon monoxide is the major gas desorbed from metals, except copper for which hydrogen is the major desorbing species. The insulators desorb hydrogen primarily.

30854 (Y/AJ—227) **Development of a rotating cathode amalgam-maker.** Schimmel, F.A. (Oak Ridge Y-12 Plant, TN (USA)). 14 Jul 1980. Contract W-7405-ENG-26. 34p. NTIS, PC A03/MF A01.

A mercury cell with vertical rotating cathodes for the preparation of lithium amalgam was developed from bench-scale to pilot-plant size. Design and operating results are reported.

30855 Carbon-induced amorphous surface layers in Ti-implanted Fe. Follstaedt, D.M.; Knapp, J.A.; Picraux, S.T. (Sandia Laboratories, Albuquerque, New Mexico 87185). DE-AC04-76DP00789. *Appl. Phys. Lett.;* **37**: No. 3, 330-333(1 Aug 1980).

Titanium implantation into high-purity Fe is shown to produce a ternary amorphous surface layer consisting of not only Fe and Ti, but also C. The amorphous layer forms at the surface and grows inward with increasing Ti fluence. The amount of C present also increases with Ti fluence and is believed to be deposited on the surface from the vacuum during implantation and to subsequently diffuse into the sample to produce the amorphous layer. For Ti concentrations < or ≃10 at.%, the amorphous layer thickness is less than the depth of the implanted Ti, but agrees with C diffusion

distances, thus demonstrating that C is an essential constituent of the amorphous phase.

30856 Nodular graphite formation in vacuum melted high purity Fe-C-Si alloys. Dhindaw, B. (Indian Inst. Tech, Kharagpur); Verhoeven, J.D. Contract W-7405-ENG-82. *Metall. Trans., A;* **11**: No. 6, 1049-1057(Jun 1980).

This paper describes a study of the cast structure of vacuum melted high purity Fe-C-Si alloys with emphasis on hypoeutectic and eutectic compositions. Nodular graphite was observed to form at high cooling rates and coral graphite at low cooling rates. This result was also confirmed by a limited study on directional solidification of alloys prepared from the same starting materials. The formation of nodular graphite at the high cooling rates was suppressed to near zero by changing the starting iron from 99.94 pct electrolytic iron to an ultra-pure zone refined iron, or by holding the melt at a low super-heat prior to cooling. Chemical analysis showed only that the impurity responsible for nodular formation was present at the low ppM level. An attempt is made to explain the appearance of the various microstructures in terms of the nucleation and growth of nodular graphite, coral graphite and the carbide structure of white iron.

30857 (SAND—80-6012) **Method of safe aluminothermic production of pure metals translation.** Sacek, J. (Sandia National Labs., Albuquerque, NM (USA)). Jun 1980. Translation of Czech Patent No. 108.235 1963. 6p. NTIS, PC A02/MF A01.

A method of safe aluminothermic production of pure metals, characterized by the fact that a smooth reaction is conducted in a rotating reaction vessel (8) located in a closed space (1) by a steady introduction of the aluminothermic mixture through an elongated opining (0) in the ceiling of the closed space.

30858 (SAND—80-6013) **Temperature of an aluminothermic process as a function of heat evolved per kilogram.** Bogolyubov, V.A. Translated from *Stal;* **17**: 531-535(1957). 20p. NTIS, PC A02/MF A01.

The theoretically established linear relationship between the temperature and the heat evolved per kilogram (kilogram heat) of an aluminothermic process was confirmed by using a tungsten-molybdenum thermocouple to investigate the temperature of aluminothermic production of thermite iron and a calorimeter to investigate the heat change of the process. This relationship may be used in practice for quick calculation of the temperature of an aluminothermic process.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 30886

30859 (CONF-800205—13) **Nuclear microanalysis as a probe of impurity-defect interactions.** Lewis, M.B.; Farrell, K. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 28p. NTIS, PC A03/MF A01.

From American Institute of Metallurgical Engineers meeting; Las Vegas, NV, USA (Feb 1980).

It is shown that nuclear microanalysis offers unique opportunities for probing impurity migration and impurity-defect interactions in irradiated materials. The principles and practice of the technique are described and the special advantages and limitations are discussed. Procedures are outlined for extracting (1) impurity diffusion coefficients, (2) impurity-defect binding energies, and (3) trap generation coefficient of heavy ions used to create displacement damage. Examples involving the impurities deuterium and helium in austenitic stainles steels and nickel are described. Preliminary values are given for: the bulk diffusion coefficient of deuterium in austenite at 25°C (1.4×10^{-12} cm^2/s); the binding energies of deuterium with point defects in austenite and of helium-3 in nickel (0.33 and 2.1 eV, respectively); and a room-temperature trap generation coefficient for deuterium in nickel-ion-bombarded austenite of ~ 15 per incident nickel ion.

30860 (DOE/ER/03158—89) **Determination of the composition of ordered Pt_3Co by atom-probe field-ion microscopy: intrinsic problems.** Yamamoto, M.; Seidman, D.N. (Cornell Univ., Ithaca, NY (USA)). May 1980. Contract AS02-76ER03158. 8p. (CONF-800730—2). NTIS, PC A02/MF A01.

From 27. international field emission symposium; Tokyo, Japan (7 Jul 1980).

Atom-probe field-ion microscope (FIM) analyses were performed on specimens of fully ordered Pt_3Co. The purpose of the investigation was to study the effects of different important experimental variables on the composition measured by the atom probe technique. The dependence of the alloy's composition on the following variables was determined: (1) pulse fraction (f); (2) specimen temperature; (3) crystal plane; and (4) field-evaporation rate. It was demonstrated that the composition determined by atom probe analyses of Pt_3Co was very sensitive to the above four variables. The observations were discussed in terms of possible field-evaporation mechanisms.

30861 (DOE/ER/03158—90) **Atom-probe field-ion microscope study of the stoichiometry of ordered Ni_4Mo.** Yamamoto, M.; Seidman, D.N. (Cornell Univ., Ithaca, NY (USA)). May 1980. Contract AS02-76ER03158. 10p. (CONF-800730—3). NTIS, PC A02/MF A01.

From 27. international field emission symposium; Tokyo, Japan (7 Jul 1980).

Atom-probe field-ion microscope analyses were performed on specimens of ordered Ni_4Mo. The (211) fundamentl and (101) superlattice planes of the body-centered tetragonal (BCT) lattice were analyzed chemically on a layer-by-layer basis. In the case of (211)/sub BCT/ fundamental planes the chemistry of each individual plane was determined as a function of depth; for eight successive (211)/sub BCT/ layers an average Mo concentration of 17.2 at. % was measured - as compared to 19.4 at. % Mo by conventional chemical techniques. Possible sources of this discrepancy were discussed. The (101)/sub BCT/ superlattice planes were found to exhibit a more complicated field evaporation behavior; the characteristic step-like field evaporation behavior was due to the partial field evaporation of a plane of Mo atoms followed by the continued field evaporation of this Mo plane, intermixed with the field evaporation of the following three planes of Ni atoms. Finally, a plane of Ni atoms was found to field evaporate. This field evaporation behavior was the result of the required crystallographic stacking of planes in the ordered Ni_4Mo structure and it repeated itself throughout the specimen. Our observations demonstrated that complicated field-evaporation processes - as well as chemistry - could be followed as a function of depth.

30862 (IS-T—908) **Yttrium-rich side of the yttrium-niobium-titanium system.** Pedersen, T.E. (Ames Lab., IA (USA)). Aug 1980. Contract W-7405-ENG-82. 56p. NTIS, PC A04/MF A01.

Thesis.

It was demonstrated that it is possible to grow aligned Nb-Ti filaments in a Y matrix. The size, spacing, and volume fraction vary almost linearly with the amount of solute present. Experiments indicate the ternary diagram is simple. Estimates of the trough composition and the associated tie lines have been determined. The eutectic compositions of four binary systems, Y-Nb, Th-Nb, Y-Ti, and Th-Ti, have been determined. The values agree fairly well with literature values except in the Y-Nb system. The higher literature value in this system is probably due to off-eutectic coupled growth giving rise to a higher apparent eutectic composition.

30863 (LBL—10178) **Secondary defects in quenched platinum.** Perez, M.I. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1979. Contract W-7405-ENG-48. 50p. NTIS, PC A03/MF A01.

Thesis.

The structure of secondary defects in two different platinum purities quenched under ultra high vacuum, has been studied by transmission electron microscopy. Faulted loops on [100] planes have been observed in both materials. In the less pure platinum, Pt B (but purer in terms of carbon content), the defects were observed after quenching, whereas in the purest one, Pt A (but less pure in terms of carbon content), the defects were formed after a long annealing. The Burgers vector of the loops formed after the quenching was a/3 <100> and for loops formed during long annealings, was a/2 <100>, apparently. It was found that in Pt B the loop density increased and the loop size decreased as the quenching temperature was lowered.The same effect was produced by increasing the carbon content by a small amount. The loop formation was totally inhibited by adding a larger amount of carbon and also when the quenching was performed in poor vacuum (~ 0.01 torr) or in air. The defects can be interpreted as pure vacancy loops heterogeneously nucleated at carbon atom clusters or, as plate like precipitates of carbon atoms and vacancies formed by a co-precipitation mechanism. The discussion of the experimental results obtained is based upon these two models.

30864 (LBL—10922) **Characterization of ferritic G.M.A. weld deposits in 9% Ni steel for cryogenic applications.** Mahin, K.W. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1980. Contract W-7405-ENG-48. 215p. NTIS, PC A10/MF A01.

Thesis.

Low temperature containment vessels of 9% Ni are normally fabricated using the shielded metal arc (S.M.A.W.) or the gas metal arc (G.M.A.W.) welding processes. Available filler metals compatible with these processes are highly alloyed austenitics, whose strength levels undermatch those of the base plate. A more efficient weld joint would be a low alloy ferritic deposit. Although acceptable matching ferritic gas tungsten arc weld (G.T.A.W.) wires have been developed, similar progress has not been made in the area of ferritic G.M.A. weld wires. Most of the prior work in this area has focused on correlating composition with mechanical properties, without a corresponding evaluation of resultant microstructure. The study presented focused on establishing correlations between chem-

istry, microstructure and mechanical properties for four different ferritic G.M.A. weld deposits in 9% Ni steel, with the purpose of developing a better understanding of the factors controlling the 77K (-196°C) toughness behavior of these weld metals. Microstructural characterization was carried out using standard optical and scanning electron microscopes, as well as a variety of advanced analytical techniques, including transmission electron microscopy (T.E.M.), scanning T.E.M., Moessbauer spectroscopy and Auger electron spectroscopy.

30865 (SAND—80-0829C) **Trapping site location for Sb in Fe-Ti-Sb-C alloys.** Knapp, J.A.; Follstaedt, D.M. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 19p. (CONF-800744—4). NTIS, PC A02/MF A01.

From Ion beam modification of materials conference; Albany, NY, USA (14 Jul 1980).

The lattice location of Sb trapped at TiC precipitates in Fe has been determined. Channeling analysis of ion-backscattering and ion-induced characteristic x-ray yields from Fe and Sb showed a substitutionality of ≧ 50% for trapped Sb relative to the Fe lattice for ion beams incident along Fe [100], [110], and [111]. In contrast, Ti x-ray yields showed channeling through the oriented TiC precipitates only along Fe [100]. We conclude that Sb is trapped at interfacial Fe sites adjacent to TiC precipitates, rather than within the TiC.

30866 (SAND—80-1109C) **Hydrogen in amorphous silicon.** Peercy, P.S. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 45p. (CONF-800744—2). NTIS, PC A03/MF A01.

From Ion beam modification of materials conference; Albany, NY, USA (14 Jul 1980).

The structural aspects of amorphous silicon and the role of hydrogen in this structure are reviewed with emphasis on ion implantation studies. In amorphous silicon produced by Si ion implantation of crystalline silicon, the material reconstructs into a metastable amorphous structure which has optical and electrical properties qualitatively similar to the corresponding properties in high-purity evaporated amorphous silicon. Hydrogen studies further indicate that these structures will accomodate ≦ 5 at.% hydrogen and this hydrogen is bonded predominantly in a monohydride (SiH_1) site. Larger hydrogen concentrations than this can be achieved under certain conditions, but the excess hydrogen may be attributed to defects and voids in the material. Similarly, glow discharge or sputter deposited amorphous silicon has more desirable electrical and optical properties when the material is prepared with low hydrogen concentration and monohydride bonding. Results of structural studies and hydrogen incorporation in amorphous silicon were discussed relative to the different models proposed for amorphous silicon.

30867 **Addendum to "Density fluctuations in liquid rubidium".** Haan, S.W.; Mountain, R.D.; Hsu, C.S.; Rahman, A. (National Measurement Laboratory, National Bureau of Standards, Washington, D.C. 20234). *Phys. Rev., A;* **22**: No. 2, 767-769(Aug 1980).

We performed molecular-dynamics simulations of liquid rubidium and the Lennard-Jones fluid at several densities and temperatures, and of a system whose pair potential is the repulsive core of the rubidium potential. In all cases, propagating density fluctuations occurred in the rubidiumlike systems at much shorter wavelengths than in the Lennard-Jones system. This indicates that the repulsive part of the pair potential is the dominant factor in determining the relaxation of short-wavelength density fluctuations.

30868 (ANL-Trans—1190) **Influence of ultrasonic vibrations on short-range order in α-aluminum bronzes.** Anchev, V.Kh. (Argonne National Lab., IL (USA)). Jul 1980. Translated from 7th conference, x-ray structure analysis in metallurgy and metallography; Ghivice, Poland, 1974, pp 174-181. 10p. NTIS, PC A02/MF A01.

The reasons of ultrasonic softening of annealed α-aluminium bronzes types Br4 and Br7 /9 at. % and 15 at. % Al/ were investigated. The observations pointed out, that the zones, located at a distance +- 2/8 from the place of the knot of ultrasonic stresses / the zone of hardening/ are subjected to softening /decreasing of hardness/ by order of 5 to 10%. The x-ray investigations of background intensity pointed out that during ultrasonic radiation there is a change of the short range order, received after annealing, i.e., the parameter of α_1 is decreasing. The decreasing of tau-values is connected with lowering of lattice friction during dislocation moving through the lattice, that is with the softening. The change of α_1 in the hardened zone is greater than in the softened zones. The temperature, time and size /grain size/ relations of tau are similar to the corresponding relations of the softening. It was supposed that the softening is connected with decreasing of the degree of short range order, this effect overcomes the effect of work hardening in the softened zones. On the other hand, the work hardening overcomes the softening connected with the disordering in the hardened zone.

30869 **Effect of nitrogen on stacking fault energy of Fe-Ni-Cr-Mn steels.** Stoltz, R.E. (Sandia Laboratories, Livermore, CA); Vander Sande, J.B. *Metall. Trans., A;* **11**: No. 6, 1033-1037(Jun 1980).

The effect of nitrogen content on stacking fault energy (SFE) has been measured in a series of Fe-21Cr-6Ni-9Mn alloys. Stacking fault energies were determined from node measurements using weak beam imaging techniques in transmission electron microscopy. Nitrogen additions lower the SFE from 53 mJ/m^2 at 0.21 wt pct to 33 mJ/m^2 at 0.24 wt pct. Further increases to 0.52 wt pct do not markedly change the SFE. Carbon and silicon had no effect on SFE in the ranges 0.010 to 0.060 wt pct C and 0.17 to 0.25 wt pct Si. The shift in SFE from 0.21 to 0.24 wt pct N is accompanied by a transition to a more planar plastic deformation mode. The sharp transition precludes the use of linear regression analysis for relating SFE to nitrogen content in this class of alloys.

30870 **Coherent α-α′ phase transition of hydrogen in niobium.** Zabel, H.; Peisl, H. (Universitaet Munchen, Germany). *Acta Metall.;* **28**: No. 5, 589-599(May 1980).

The α-α′ phase transition of hydrogen in niobium closely resembles a gas-liquid transition of a real gas and is attributed to the elastic interaction via the lattice distortions due to the hydrogen atoms. Because of the range of the interaction, the critical fluctuations at the critical point of the α-α′ transition are drastically suppressed in a coherent lattice. X-ray scattering studies of Nb crystals, loaded in situ with hydrogen, show that, below the critical point, coherent inhomogeneous hydrogen density fluctuations exist. They are due to a smooth density variation over the whole sample size and depend sensitively on its shape through the fulfilment of the elastic boundary condition.

30871 **Origin of cell walls and of lattice misorientations during deformation.** Kocks, U.F.; Hasegawa, T.; Scattergood, R.O. (Argonne National Lab., IL). *Scr. Metall.;* **14**: No. 4, 449-454(Apr 1980).

The mechanism by which cell walls form during strain hardening and dynamic recovery is outlined. This mechanism helps explain some inconsistencies between x-ray and TEM observations of misorientations and could contribute to a theory of nucleation for recrystallization. (FS)

30872 **Effect of trace element additions on the grain boundary composition of Ir+0.3% W alloys.** White, C.L.; Clausing, R.E.; Heatherly, L. (Oak Ridge National Lab., TN (USA)). *Philos. Trans. R. Soc. London, Ser. A;* **295**: No. 1413, 303(7 Feb 1980).

From Residuals, additives and materials properties. A joint symposium of the Metals Society, the National Physical Laboratory and the Royal Society; London, UK (15 - 17 May 1978).

30873 **Grain boundaries and ionic conduction in sodium beta alumina.** DeJonghe, L.C. (Cornell Univ., Ithaca, NY). *J. Mater. Sci.;* **14**: 33-48(1979).

Grain boundary morphology and structure has been examined by means of transmission electron microscope lattice imaging, and a plausible correlation is advanced between the grain boundary structure and its transgranular ionic resistivity and capacitance. The geometrical aspects and resistance of the grain boundaries depend on whether or not dislocations with a b = 1 spinel block can accommodate the misorientation. Such dislocatons are shown to exist in a wide range of grain boundaries. The wide spread in grain boundary structure and the complexity of the microstructure, making parallel current path considerations necessary, can account qualitatively for the deviation from the ideal Maxwell dispersive behaviour. However, a physically relevant interpretation of equivalent circuit parameters determined from dispersive type measurements seems not justified. Several model circuits are used to illustrate the interpretational difficulties. The structure and effects of intergranular phases also have been studied and are discussed.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 30642, 30848, 30864, 30888, 30906, 30920, 31406, 31411

30874 (EPRI-NP—1413) **Measurement of residual stresses in Type-304 stainless steel piping butt weldments. Phase report.** Shack, W.J.; Ellingson, W.A.; Pahis, L.E. (Argonne National Lab., IL (USA)). Jun 1980. Contract W-31-109-ENG-38. 135p. NTIS, PC A07/MF A01.

Residual stresses have been shown to be a major factor contributing to intergranular stress corrosion cracking of weldments in austenitic stainless steel. Residual stresses developed during welding are measured for three pipe sizes including 4-, 10-, and 26-inch-diameter, schedule-80, type-304 stainless steel. Significant differences are found in both magnitude and distribution as a function of pipe size. Effects of preweld surface treatments are also evaluated.

30875 (HEDL-SA—1898-FP) **In-sodium creep behavior of alloys M-813 and Nimonic PE16.** Anantatmula, R.P.; Gilbert, E.R. (Hanford Engineering Development Lab., Richland, WA (USA)).

Apr 1980. Contract AC14-76FF02170. 19p. (CONF-800401—23). NTIS, PC A02/MF A01.

From 2. international conference of liquid metal technology for energy systems; Richland, WA, USA (20 Apr 1980).

The in-sodium biaxial creep deformation of internally pressurized tube specimens of alloys M-813 and Nimonic PE16 was measured at 650°C under constant stress conditions after 4000 hours of sodium exposure. Each alloy had specimens at two different stress levels, viz., 0 and 165 MPa (24,000 psi). The data showed negative diameter changes at zero stress, which were attributed to material densification associated with precipitation. Although material densification was also seen in comparable in-argon experiments, the in-sodium creep strains at 165 MPa and 650°C were much lower than the corresponding in-argon values. The higher creep strains in argon are explained on the basis of two parallel mechanisms involving oxygen, which is present at a low level in sodium (1 ppM) as compared with approximately 1000 ppM in the argon environment. The trends in the current data are consistent with observations by earlier authors. Sodium exposure of Nimonic PE16 also resulted in 4 μm deep intergranular penetration, which did not have any apparent effect on its biaxial creep behavior.

30876 (HEDL-SA—2102-FP) **Fracture toughness testing on miniature specimens using the electropotential techniques.** Huang, F.H.; Wire, G.L. (Hanford Engineering Development Lab., Richland, WA (USA)). 11 Feb 1980. Contract AC14-76FF02170. 25p. (CONF-800673—3). NTIS, PC A02/MF A01.

From 13. national symposium on fracture mechanics; Philadelphia, PA, USA (8 Jun 1980).

Ferritic steels are currently being considered as fusion first wall candidates because of the relatively low thermal stresses induced during temperature cycles. However, fracture toughness is of concern in this alloy class. Limitations on irradiation space dictate that special techniques by developed for post-irradiation fracture toughness measurements. This study investigates the feasibility of electropotential techniques using single specimens to evalute fracture toughness. The electropotential technique was applied to obtain continuous crack extension measurements on miniaturized specimens and to trace out J versus Δa curves. The J-integral results obtained from A286 small specimens compare favorably with those obtained from large specimens. Also, the experimental work shows that electropotential and multiple specimen methods produce consistent data in HT-9 in the transition region where crack extension occurs by mixed cleavage and dimpled rupture.

30877 (HEDL-SA—2139) **More basic approach to the analysis of multiple specimen R-curves for determination of J/sub c/.** Carlson, K.W.; Williams, J.A. (Hanford Engineering Development Lab., Richland, WA (USA)). Feb 1980. Contract AC14-76FF02170. 35p. (CONF-800673—1). NTIS, PC A03/MF A01.

From 13. national symposium on fracture mechanics; Philadelphia, PA, USA (8 Jun 1980).

Multiple specimen J-R curves were developed for groups of 1T compact specimens with different a/W values and depth of side grooving. The purpose of this investigation was to determine J/sub c/ (J at onset of crack extension) for each group. Judicious selection of points on the load versus load-line deflection record at which to unload and heat tint specimens permitted direct observation of approximate onset of crack extension. It was found that the present recommended procedure for determining J/sub c/ from multiple specimen R-curves, which is being considered for standardization, consistently yielded nonconservative J/sub c/ values. A more basic approach to analyzing multiple specimen R-curves is presented, applied, and discussed. This analysis determined J/sub c/ values that closely corresponded to actual observed onset of crack extension.

30878 (IS-T—903) **Effect of nitrogen concentration and temperature on the critical resolved shear stress and strain rate sensitivity of vanadium.** Rehbein, D.K. (Ames Lab., IA (USA)). Aug 1980. Contract W-7405-ENG-82. 71p. NTIS, PC A04/MF A01.

Thesis.

The critical resolved shear stress and strain rate sensitivity were measured over the temperature range from 77 to 400°K for vanadium-nitrogen alloys containing from 0.0004 to 0.184 atom percent nitrogen. These properties were found to be strongly dependent on both the nitrogen concentration and temperature. The following observations were seen in this investigation: the overall behavior of the alloys for the temperature and concentration range studied follows a form similar to that predicted; the concentration dependence of the critical resolved shear stress after subtracting the hardening due to the pure vanadium lattice obeys Labusch's c/sup 2/3/ relationship above 200°K and Fleischer's c/sup 1/2/ relationship below 200°K; the theoretical predictions of Fleischer's model for the temperature dependence of the critical resolved shear stress are in marked disagreement with the behavior found; and the strain rate sensitivity, ∂ tau/∂ln γ, exhibits a peak at approximately 100°K that decreases in height as the nitrogen concentration increases. A similar peak has been observed in niobium by other investigators but the effect of concentration on the peak height is quite different.

30879 (LA-UR—80-1543) **Improved technique for determining dynamic material properties using the expanding ring.** Warnes, R.H.; Duffey, T.A.; Karpp, R.R.; Carden, A.E. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 15p. (CONF-800641—1). NTIS, PC A02/MF A01.

From International conference on the metallurgical effects of high strain rate deformation and fabrication; Albuquerque, NM, USA (22 Jun 1980).

Since its introduction nearly two decades ago, the expanding ring test has shown considerable promise as a simple method of obtaining strain-rate-sensitive uniaxial material property data. The procedure is to monitor the kinematics of a uniformly expanding ring. The stress-strain-strain rate response of the ring material can then be calculated from the ring equation of motion and the recorded data. Efforts in the past have been based upon recording the transient displacement of the ring. Determination of the stress in the ring then required double differentiation with respect to time of the ring displacement. The work reported herein is an attempt to overcome this difficulty by directly measuring ring velocity as a function of time by means of a laser velocity interferometer; this method requires one less differentiation of the data. The procedure is illustrated by experiments performed on annealed and hardened copper rings. Results are compared to quasi-static material properties determined for the same materials using conventional techniques.

30880 **Fracture stress of single-crystal zinc.** Stahl, D. (Argonne National Lab., IL); Margolin, H. *Metall. Trans., A;* **11**: No. 6, 891-897(Jun 1980).

The basal plane fracture stress of 99.999 pct pure single-crystal zinc tensile specimens was determined from 77 to 298°K as a function of strain rate. The fracture stress was found to be dependent on the size of existing flaws associated with surface preparation, when the thermal variation of surface energy was taken into account. The stress at fracture was independent of strain and strain rate and was inversely proportional to the square root of the corrected flaw size, suggesting that a Griffith-type equation was obeyed to high strains. When flaws do not exist or are negligibly small, fracture is believed to be nucleated by the splitting of subboundaries as a result of plastic flow. The strain at fracture for constant fracture stress decreases with an increase in strain rate and a decrease in temperature and depends on the values of the work-hardening coefficient and exponent.

30881 **Density measurements as an assessment of creep damage and cavity growth.** Miller, D.A. (Central Electricity Generating Board, Bristol, England); Langdon, T.G. *Metall. Trans., A;* **11**: No. 6, 955-962(Jun 1980).

The change in density during creep of several polycrystalline metals may be correlated where -Δ rho is the density change, rho is the original density, ϵ is the strain, t is the time, d is the linear intercept grain size, σ is the applied stress, G is the shear modulus, Q/sub gb/ is the activation energy for grain boundary diffusion, R is the gas constant, T is the absolute temperature, and B and q are constants with q ≃ 2 to 3. This expression is consistent with the theory of unconstrained grain boundary diffusion growth of cavities provided there is also concomitant strain-dependent nucleation. The expression does not support the power-law growth of cavities, growth by surface diffusion, or constrained grain boundary diffusion growth.

30882 **Deformation and fracture characteristics of Inconel X-750 at room temperature and elevated temperatures.** Mills, W.J. (Hanford Engineering Development Lab., Richland, WA). Contract DE-AC14-76FFO2170. *Metall. Trans., A;* **11**: No. 6, 1039-1047(Jun 1980).

Electron fractographic and thin foil electron metallographic techniques were used to evaluate the deformation and fracture characteristics of Inconel X-750 at temperatures ranging from 24 to 816°C. Operative dislocation mechanisms and fracture surface morphologies were related to the overall tensile response of this nickel-base superalloy. At room temperature, failure occurred primarily by an intergranular dimple rupture mechanism associated with microvoid coalescence along grain boundary denuded regions. A fairly high density of dislocations throughout the matrix resulted in relatively high ductility levels even though failure occurred by an intergranular mechanism. Under intermediate temperature conditions (316 to 427°C), increased transgranular fracture coupled with extensive dislocation activity within the Inconel X-750 matrix caused a slight increase in ductility. At progressively higher temperatures, 538 to 704°C, all dislocation activity was channeled through narrow slip bands which subsequently initiated localized separation and resulted in a very faceted fracture surface appearance. The absence of a homogeneous dislocation substructure in this temperature regime resulted in a severe degradation in ductility levels. At the highest test temperature (816°C), a uniform dislocation network throughout the Inconel X-750 matrix coupled with intense dislocation activity in the grain boundary denuded zone resulted in a marked improvement in ductility. Furthermore, the extensive dislocation activity along grain boundary regions ultimately resulted in an intergranular fracture morphology.

30883 Formation of water vapor bubbles in copper and their effect on intergranular creep fracture. Nieh, T.G.; Nix, W.D. (Stanford Univ., CA). Contract DE-AS03-76SF00326. *Acta Metall.;* **28**: No. 5, 557-566(May 1980).

Small, closely spaced water vapor bubbles are formed along grain boundaries in coarse grained copper by annealing first in air at 800°C and then in hydrogen at 600°C. Almost all of the cavities are formed at grain boundaries, primarily because oxygen strongly segregates to grain boundaries in copper. The average cavity diameter and planar spacing are found to be 0.8 and 3.2 μm, respectively. A study of the creep fracture properties of copper containing the above cavity microstructure indicates that intergranular cavity growth is controlled by the rate of self diffusion along the cavity surface in the manner first described by Chuang and Rice. The stress dependence of the rupture time is found to be of the form t/sub r/ ~ σ^{-3}. The temperature dependence for fracture is characterized by an activation energy of 92 kJ/mol, which is close to that for surface self diffusion. These properties, together with the absolute rupture times are in close agreement with the Chuang-Rice theory in the limit of surface diffusion control. The determination fo the controlling fracture mechanism is supported by metallographic and fractographic evidence.

30884 Stress and temperature dependence of steady-state flow at intermediate temperatures for pure polycrystalline aluminum. Luthy, H.; Miller, A.K.; Sherby, O.D. (Stanford Univ., CA). Contract EY-76-S-03-326. *Acta Metall.;* **28**: No. 2, 169-178(Feb 1980).

Torsion tests to large strains (ϵ = 3 to 10) in the intermediate temperature range (0.2 to 0.6T/sub m/ where T/sub m/ is the melting temperature in degrees absolute) have been performed on high purity aluminum. Steady-state was reaeff/ utilized is based on all published diffusion data, namely two different additive lattice self-diffusion coehed at all temperatures except for 0.2 T/sub m/. Between 0.29 and 0.48 T/sub m/ the activation energy for steady-state creep (Q/sub ss/) was found to be equal to about 87 kJ $mole^{-1}$ which corresponds quite closely to the activation energy for dislocation pipe diffusion as measured by Volin, Lie and Balluff using a void shrinkage analysis. The relation between stress, σ/sub ss/, and strain rate, ϵ/sub ss/, in steady-state has been analyzed using an effective diffusion coefficient, D/sub eff/, for creep data over the temperature range 0.21 to 0.93 T/sub m/. The D/sub eff/ utilized is based on all published diffusion data namely two different additive lattice self-diffusion coefficients and one dislocation pipe diffusion coefficient. Over 21 orders of magnitude in ϵ/sub ss//D/sub eff/, the data fit the equation E/sub ss//D/sub eff/ = B (sinh(α σ/sub ss//E)))/sup n, where α, B and n are constants and E is the dynamic unrelaxed average Young's modulus. This Garofalo-type hyperbolicsine equation is therefore a good representation of the steady-state behavior of pure polycrystalline aluminum. The activation energy for transient deformation, Q/sub trans/, was found to be dependent upon the method of testing. Q/sub trans/ was greater than Q/sub ss/ when calculated from temperature-change tests but less than Q when calculated from constant temperature tensile tests.

PHYSICAL PROPERTIES

30885 (CONF-800670—1) **Thermal transport properties of niobium and some niobium base alloys from 80 to 1600°K.** Moore, J.P.; Graves, R.S.; Williams, R.K. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 24p. NTIS, PC A02/MF A01.

From 7. European thermophysical properties conference; Antwerpen, Belgium (30 Jun 1980).

The electrical resistivities and absolute Seebeck coefficients of 99.8 at. % niobium with a RRR of 36, Nb-4.8 at. % W, Nb-5 at. % Mo, Nb-10 at. % Mo, and Nb-2.4 at. % Mo-2.4 at. % Zr were measured from 80 to 1600°K, and the thermal conductivities of the niobium and Nb-5 at. % W were measured from 80 to 1300°K. A technique is described for measuring the electrical resistivity and Seebeck coefficient of a specimen during radial heat flow measurements of the thermal conductivity. The transport property results, which had uncertainties of +-0.4%for electrical resistivity and +-1.4% for thermal conductivity, showed the influence of tungsten and molybdenum solutes on the transport properties of niobium and were used to obtain the electronic Lorenz function of pure niobium, which was found to approach the Sommerfeld value at high temperatures.

30886 (DOE/ER/02995—4) **Imaging of surfaces and defects of crystals. Progress report, May 1, 1979-May 31, 1980.** Cowley, J.M. (Arizona State Univ., Tempe (USA). Dept. of Physics). Jun 1980. Contract AC02-76ER02995. 17p. NTIS, PC A02/MF A01.

Application of the novel techniques developed in this laboratory and especially those resulting from our modifications of the scanning transmission electron microscope, have allowed considerable progress with studies on the oxidation of chromium and chromium-iron alloys and on the surface structure of magnesium oxide and related materials. Microdiffraction from regions 10 to 20A in diameter has allowed clarification of the nature and epitaxial relationships of the very thin oxide layers formed when chromium films are heated. The new observations include the existence of a uniform thin layer of a previously undetected spinel-structure phase. Deductions have been made on the factors influencing growth of the oxide layers. Also it has been shown by use of STEM imaging, microdiffraction and ELS that the oxide film formed on thin chromium films in air at room temperature is amorphous and about 5A thick. The development of techniques for the study of surfaces by reflection diffraction imaging have allowed the visualization of growth steps only 2 to 5A high on the surfaces of MgO smoke particles and a combination of ELS, imaging and diffraction methods has permitted the detection of excited surface states of the first few atomic layers on crystal surfaces. The observation of a new type of interference fringe in defocussed images of small crystals promises to provide extremely sensitive methods for study of the variations of potential at crystal surface. Remodelling of the medium-energy electron diffraction and microscopy system should allow greatly improved performance for surface studies.

30887 (LA-UR—80-1693) **KrF-laser annealing of native oxides on GaAs.** Ahrenkiel, R.K.; Anderson, G.; Dunlavy, D.; Maggiore, C.; Hammond, R.B.; Stotlar, S. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 6p. (CONF-800647—3). NTIS, PC A02/MF A01.

From International conference on the physics of MOS insulators; Raleigh, NC, USA (18 Jun 1980).

Annealing of native oxides grown on GaAs has been performed using a pulsed KrF laser. This process allows the oxides to be heated to temperatures well above 350°C without arsenic loss from the GaAs substrate. The physical, chemical, and electronic properties of the oxide are markedly changed by laser processing.

30888 Adhesive wear polishing of molybdenum alloy. Miller, N.E. (Bendix Corp., Kansas City, MO). Contract DE-AC04-76-DP00613. *Metallography;* **13**: No. 2, 135-142(Apr 1980).

Mechanical polishing of molybdenum alloy (0.5% Ti, 0.1% Zr) was investigated. The test specimens were 25-mm. diameter spheres. Using conventional abrasive methods, the wear rate during polishing was too low to achieve the desired metallographic surface quality. The low abrasive wear rate was explained by the presence of a hard oxide film on the surface of the alloy. An alternative polishing method based on adhesive wear was developed.

30889 (LBL—10633) **High-temperature thermodynamic activities of zirconium in platinum alloys determined by nitrogen-nitride equilibria.** Goodman, D.A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1980. Contract W-7405-ENG-48. 82p. NTIS, PC A05/MF A01.

Thesis.

A high-temperature nitrogen-nitride equilibrium apparatus is constructed for the study of alloy thermodynamics to 2300°C. Zirconium-platinum alloys are studied by means of the reaction $9ZrN + 11Pt \rightarrow Zr_9Pt_{11} + 9/2\ N_2$. Carful attention is paid to the problems of diffusion-limited reaction and ternary phase formation. The results of this study are and a/sub Zr//sup 1985°C/ = 2.4 x 10^{-4} in Zr_9Pt_{11} ΔG/sub f 1985°C/° $Zr_9Pt_{11} \leqq$ -16.6 kcal/g atom. These results are in full accord with the valence bond theory developed by Engel and Brewer; this confirms their prediction of an unusual interaction of these alloys.

30890 Upper critical field of Nb: Calculated temperature dependence and anisotropy. Butler, W.H. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). W-7405-ENG-26. *Phys. Rev. Lett.;* **44**: No. 23, 1516-1520(9 Jun 1980).

The magnitude, anisotropy and temperature dependence of the H/sub c/2 for Nb are calculated from the underlying electronic structure. Excellent agreement between theory and experiment results if experimental Fermi velocities are used and if Fermi-velocity—anisotropy, strong-coupling, and impurity effects are included.

30891 Surface-state contribution to the electroreflectance of noble metals. Ho, K.; Harmon, B.N.; Liu, S.H. (Ames Laboratory—U. S. Department of Energy and Department of Physics, Iowa State University, Ames, Iowa 50011). W-7405-ENG-82. *Phys. Rev. Lett.;* **44**: No. 23, 1531-1534(9 Jun 1980).

The effect of electromodulation of surface states on the electroreflectance of Ag(110) is investigated with use of results from a first-principles self-consistent pseudopotential calculation of the surface electronic structure. Our model explains the polarization anisotropy observed on the (110) face of Ag, Cu and Au. A broadening of the surface state by ~ 1 eV is explained by interactions of water dipoles at the metal-electrolyte interface.

30892 Mechanism of hydrogen embrittlement adsorption or decohesion. Sieradzki, K. (Iowa State Univ., Ames); Ficalora, P. *Scr. Metall.;* **14**: No. 6, 641-644(Jun 1980).

Mathematical models of hydrogen embrittlement adsorption or decohesion are evaluated. (FS)

30893 **Nature of the hysteretic behavior in GdCu compound.** Gefen, Y. (Nuclear Research Center Negev, Beer Sheva, Israel); Rosen, M. Contract W-7405-ENG-48. *Scr. Metall.;* **14**: No. 6, 645-648(Jun 1980).

The behavior of the change in length and electrical resistivity of GdCu over a wide temperature range was studied to gain insight into reasons for the observed anomaly. (FS)

30894 **Diffusion of hydrogen in niobium-tantalum alloys at 296°K.** Peterson, D.T.; Jensen, C.L. *Metall. Trans., A;* **11**: 627-628(Apr 1980).

The diffusivity of hydrogen in niobium (Cb), tantalum and three niobium-tantalum alloys has been measured at 296°K by a macroscopic technique based on the Boltzmann-Matano analysis. The hydrogen diffusivity extrapolated to zero concentration does not vary linearly with alloy concentration but rather appears to be less than would be predicted by a linear interpolation between the diffusivity of hydrogen in pure niobium and tantalum. The dependence of hydrogen diffusivity on hydrogen concentration was also determined. In each alloy, the diffusivity was found to decrease with increasing hydrogen concentration. The diffusion coefficient for hydrogen decreased by approximately a factor of two as the hydrogen concentration increased from zero to the solubility limit in each metal.

30895 **Equivalence of two methods for computing the activation entropy for dislocation motion.** Dimelfi, R.J. (Argonne National Lab., IL); Nix, W.D.; Barnett, D.M.; Pound, G.M. *Acta Metall.;* **28**: No. 2, 231-237(Feb 1980).

It is shown that the equation for the entropy of activation for dislocation motion, derived previously by the authors, is in accordance with the classical definition of that quantity. The proof is presented in three stages. First, the entropy to form a dislocation in a linear elastic solid, to which no external tractions are applied, is calculated using both approaches. It is shown that both methods yield the same result. In the second stage, the entropy associated with the motion of a dislocation from a ground to an activated state, in a solid subjected to a uniform applied stress, is formulated. It is proven that the entropy of activation in this case is given by the difference between the formation entropies of the ground and activated states. This result illustrates that the entropy of activation is determined entirely by the internal stress states, and is independent of stresses produced by the applied tractions. Finally, a more general proof of the identity of the two methods is presented.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 30064, 30066, 30123, 30127

30896 (BDX—613-2435) **Thin film corrosion. Final report.** Raut, M.K. (Bendix Corp., Kansas City, MO (USA)). Jun 1980. Contract AC04-76DP00613. 26p. NTIS, PC A03/MF A01.

Corrosion of chromium/gold (Cr/Au) thin films during photolithography, prebond etching, and cleaning was evaluated. Vapors of chromium etchant, tantalum nitride etchant, and especially gold etchant were found to corrosively attack chromium/gold films. A palladium metal barrier between the gold and chromium layers was found to reduce the corrosion from gold etchant.

30897 (DOE/ER/01198—1310) **Panel report on corrosion in energy systems.** (Illinois Univ., Urbana (USA). Materials Research Lab.). Jun 1979. Contract AC02-76ER01198. 135p. NTIS, PC A07/MF A01.

Corrosion problems in high-temperature (non aqueous) energy systems, corrosion in aqueous energy systems and institutional problems inhibiting the development of corrosion science and engineering are discussed. (FS)

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 30623, 30632, 31398, 31416

30898 (HEDL-SA—1512-FP) **Reduction of irradiation-induced creep and swelling in AISI 316 by compositional modifications.** Bates, J.F.; Powell, R.W.; Gilbert, E.R. (Hanford Engineering Development Lab., Richland, WA (USA)). Mar 1978. Contract AC14-76FF02170. 34p. (CONF-800609—7). NTIS, PC A03/MF A01.

From 10. international symposium on effects of radiation on materials; Savannah, GA, USA (3 Jun 1980).

Studies involving high fluence irradiations of compositionally modified AISI 316 stainless steel have demonstrated that the irradiation-induced creep and swelling of this alloy can be modified through a selective choice of alloying elements. Irradiation-induced swelling of specimens irradiated to fluences of 7 to 12 x 10^{22} n/cm^2 ($E > 0.1$ MeV) is strongly influenced by the concentration of alpha-stabilizing elements such as Si and Mo. Relative minima and maxima in swelling vs composition diagrams are shown to exist. Irradiation-induced creep strain of AISI 316 is, in general, reduced by the same elements which reduce irradiation-induced swelling. It was found that the compositional dependence of swelling and creep in this alloy system can both be described through a description of the screening of dislocation strain fields. Compositional modifications which increase the mobility of the screening agents or allow the formation of more effective screening agents will decrease the swelling and irradiation creep. This screening results in a decrease in the interstitial-dislocation bias, which results in lower swelling and in reactor creep.

30899 (HEDL-SA—1883) **Analysis of radiation-induced microchemical evolution in 300 series stainless steel.** Brager, H.R.; Garner, F.A. (Hanford Engineering Development Lab., Richland, WA (USA)). Mar 1980. Contract AC14-76FF02170. 23p. (CONF-800205—12). NTIS, PC A02/MF A01.

From American Institute of Metallurgical Engineers meeting; Las Vegas, NV, USA (Feb 1980).

The irradiation of 300 series stainless steel by fast neutrons leads to an evolution of alloy microstructures that involves not only the formation of voids and dislocations, but also an extensive repartitioning of elements between various phases. This latter evolution has been shown to be the primary determinant of the alloy behavior in response to the large number of variables which influence void swelling and irradiation creep. The combined use of scanning transmission electron microscopy and energy-dispersive x-ray analysis has been the key element in the study of this phenomenon. Problems associated with the analysis of radioactive specimens are resolved by minor equipment modifications. Problems associated with spatial resolution limitations and the complexity and heterogeneity of the microchemical evolution have been overcome by using several data acquisition techniques. These include the measurement of compositional profiles near sinks, the use of foil-edge analysis, and the statistical sampling of many matrix and precipitate volumes.

30900 (HEDL-SA—2001-FP) **Microchemical evolution of neutron-irradiated stainless steel.** Brager, H.R.; Garner, F.A. (Hanford Engineering Development Lab., Richland, WA (USA)). Apr 1980. Contract AC14-76FF02170. 19p. (CONF-800609—13). NTIS, PC A02/MF A01.

From 10. international symposium on effects of radiation on materials; Savannah, GA, USA (3 Jun 1980).

The precipitates that develop in AISI 316 stainless steel during irradiation play a dominant role in determining the dimensional and mechanical property changes of this alloy. This role is expressed primarily in a large change in matrix composition that alters the diffusional properties of the alloy matrix and also appears to alter the rate of acceptance of point defects at dislocations and voids. The major elemental participants in the evolution have been identified as nickel, silicon, and carbon. The exceptional sensitivity of this evolution to many variables accounts for much of the variability of response exhibited by this alloy in nominally similar irradiations.

30901 (HEDL-SA—2002-FP) **Frank loop formation in irradiated metals in response to applied and internal stresses.** Gelles, D.S.; Garner, F.A.; Brager, H.R. (Hanford Engineering Development Lab., Richland, WA (USA)). Apr 1980. Contract AC14-76FF02170. 21p. (CONF-800609—12). NTIS, PC A02/MF A01.

From 10. international symposium on effects of radiation on materials; Savannah, GA, USA (3 Jun 1980).

The Frank loop and dislocation microstructures developed in three face-centered cubic alloys during fast reactor irradiation have been examined to determine the influence of applied and internally-generated stress on loop evolution. It is shown that anisotropic stresses generate a corresponding anisotropy of Frank loop populations on the four close-packed planes. The loop populations thus represent a microstructural record of the irradiation creep processes in action. The ease of interpreting this record depends on the relative magnitudes of external and internal stresses. Metals with low irradiation creep rates which also undergo concurrent and substantial phase changes during irradiation are subject to large and indeterminate levels of internally-generated stress which render the microstructural record uninterpretable with respect to the applied stress state. When the internally-generated stresses are small in comparison to the externally-applied stresses, a clear record of the SIPA (Stress-Induced-Preferential-Absorption) growth mechanism of irradiation creep is imprinted at low neutron fluences in the density and sizes of loops present on each set of close-packed planes. This record fades at higher fluences when the continued anisotropic formation, growth and unfaulting of Frank loops generates a corresponding anisotropy in the resultant free dislocation network, a process which alters the competition of sinks for point defects.

30902 (HEDL-SA—2004-FP) **Stress-enhanced swelling of metal during irradiation.** Garner, F.A.; Gilbert, E.R.; Porter, D.L. (Hanford Engineering Development Lab., Richland, WA (USA); Argonne National Lab., IL (USA)). Apr 1980. Contract AC14-76FF02170. 25p. (CONF-800609—4). NTIS, PC A02/MF A01.

From 10. international symposium on effects of radiation on materials; Savannah, GA, USA (3 Jun 1980).

Data are available which show that stress plays a major role in the development of radiation-induced void growth in AISI 316 and many other alloys. Earlier experiments came to the opposite conclusion and are shown to have investigated stress levels which inadvertantly cold-worked the material. Stress-affected swelling spans the entire temperature range in fast reactor irradiations and accelerates with increasing irradiatin temperature. It also appears to operate in all alloy starting conditions investigated. Two major microstructural mechanisms appear to be causing the enhancement of swelling, which for tensile stresses is manifested primarily as a decrease in the incubation period. These mechanisms are stress-induced changes in the interstitial capture efficiency of voids and stress-induced changes in the vacancy emission rate of various microstructural components. There also appears to be an enhancement of intermetallic phase formation with applied stress and this is shown to increase swelling by accelerating the microchemical evolution that precedes void growth at high temperature. This latter consideration complicates the extrapolation of these data to compressive stress states.

30903 (HEDL-SA—2045-FP) **Microstructural interpretation of the fluence and temperature dependence of the mechanical properties of irradiated AISI 316.** Johnson, G.D.; Garner, F.A.; Brager, H.R.; Fish, R.L. (Hanford Engineering Development Lab., Richland, WA (USA)). 17 Apr 1980. Contract AC14-76FF02170. 29p. (CONF-800609—10). NTIS, PC A03/MF A01.

From 10. international symposium on effects of radiation on materials; Savannah, GA, USA (3 Jun 1980).

The effects of neutron irradiation on the mechanical properties of annealed and 20% cold-worked AISI 316 irradiated in EBR-II were determined for the temperature regime of 370 to 760°C for fluences up to 8.4 x 10^{22} n/cm² (E > 0.1 MeV). At irradiation temperatures below about 500°C, both annealed and cold-worked material exhibit a substantial increase in the flow stress with increasing fluence. Furthermore, both materials eventually exhibit the same flow stress, which is independent of fluence. At temperatures in the range of 538 to 650°C, the cold-worked material exhibits a softening with increasing fluence. Annealed AISI 316 in this temperature regime exhibits hardening and at a fluence of 2 to 3 x 10^{22} n/cm² (E > 0.1 MeV) reaches the same value of flow stress as the cold-worked material.

30904 **Kinetics of void annealing in neutron irradiated aluminum.** Vandermeer, R.A.; Ogle, J.C. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Acta Metall.;* **28**: No. 2, 151-161(Feb 1980).

The kinetics of void annealing in neutron-irradiated, high purity aluminum containing 0.006 void volume fraction was studied by means of dilatometry. Over the temperature range 358 to 573°K, the isothermal recovery of void volume fraction exhibited a logarithmic kinetic behavior. The data were analyzed in terms of a recovery rate equation of the form $df/dt = -fK_1 \exp - (Q_0 - \beta f/RT)$. A theory for void annealing in irradiated aluminum is described based on the premise that voids shrinking under the action of interfacial forces emit single vacancies which migrate by diffusion to internal sinks where they are annihilated. In the theory, Q_0 is equal to the self diffusion activation energy. For the parameters Q_0 and K_1, satisfactory agreement between theory and experiment was achieved. The theory as presented cannot account for the prameter β. Its influence on recovery was speculated to be related to the damage state of the material. The ratio-of-slopes method was used to analyze recovery rate data from isochronal experiments. In common with the isothermal results, the measured activation energy for void annealing was found to be a function of how much void volume fraction remained to be annealed. An approximate void size distribution function was derived which agreed satisfactorily with experiment.

30905 **In situ field-ion microscope study of the recovery behavior of ion-irradiated tungsten and tungsten alloys.** Wilson, K.L. (Sandia Lab., Livermore, CA); Baskes, M.I.; Seidman, D.N. *Acta Metall.;* **28**: No. 1, 89-102(Jan 1980).

Five grades of tungsten specimens with different purity levels (resistivity ratios R of 5 x 10^4, 1.5 x 10^4, 50, 15 and 5) were irradiated in situ with 30 keV W^+ ions to a dose of typically 5 x 10^{12} ion cm^{-2} at 18°K. Examination with a low-temperature field-ion microscope (FIM) showed the isochronal-annealing spectra of the specimens to result from a large self-interstitial atom (SIA) flux at ~ 38°K, followed by significant SIA flux from ~ 50 to 80°K and a small amount of additional recovery up to 120°K. The spectra for these five different R value specimens were essentially identical between 18 and 120°K. High-purity W specimens (R = 5 x 10^4) doped with 5 x 10^{-5} to 1 x 10^{-4} atom fraction carbon showed only a small reduction in the amount of recovery observed for the long-range migration peak at 38°K. The isochronal recovery spectra for W-Re alloy specimens (5 x 10^{-3} and 3 x 10^{-2} atom fraction Re) were radically different from the isochronal recovery spectra of pure W specimens. For both alloys the recovery of the Stage I long-range migration peak at 38°K was strongly suppressed; for the 3 x 10^{-2} atom fraction alloy, all recovery from 18 to 120°K was virtually eliminated.

30906 **SIPA contribution to radiation creep.** Nichols, F.A. (Argonne National Lab., IL (USA)). *J. Nucl. Mater.;* **84**: No. 1-2, 207-221(Oct 1979).

The original suggestion of Heald and Speight (1974) that preferential attraction of interstitials to dislocations with Burgers vectors parallel to an applied tensile stress could give rise to an irradiation creep component has been analyzed and discussed by other authors. However, no internally consistent theoretical analysis has been presented, so the magnitude of the effect expected is not well established. The author presents the results of such an analysis, compares and contrasts it with previous treatments and asseses the conditions under which it may contribute significantly to observed creep strains.

CERAMICS, CERMETS, AND REFRACTORIES

REFER ALSO TO CITATION(S) 30094, 30103

30907 (FE—2556-30) **Development of a ceramic tube heat exchanger with relaxing joint. Final report, January 1977-June 1980.** Ward, M.E.; Solomon, N.G.; Gulden, M.E.; Smeltzer, C.E. (Solar Turbines International, San Diego, CA (USA)). Jun 1980. Contract AC01-77ET10571. 289p. NTIS, PC A13/MF A01.

Advances in ceramic heat exchanger technology have been aided by work completed under the area investigated by this project. For four tubular ceramic materials, all silicon carbide, statistical strengths have been measured and documented from ambient temperature up to 1370°C 950Advances in ceramic heat exchanger technology have been aided by work completed under the area investigated by this project. For four tubular ceramic materials, all silicon carbide, statistical strengths have been measured and documented from ambient temperature up to 1370°C (2500°F). Of the four materials tested, none were found to possess exceptional strength or probability of failure properties when compared to others in the test group. All material had Weibull modulus's of four to nine with mean material strength ranging from 58.9 to 117 MPa (8.5 to 17 ksi). Three of the ceramic materials were tested for 1000 hours in a simulated high sodium, coal-fired environment. Tests were conducted at gas temperatures of 1370°C (2500°F). Two of the materials tested were not significantly affected. The other, alpha-sintered SiC, had a reduction in tube wall thickness at the leading edge. Joining of ceramics has significantly been improved as a result of this project. Glass bonded ceramic joints have been manufactured and successfully tested at operating temperature and pressure. Brazed ceramic joints in which a metal was used to bond ceramic components has been successfully tested and used as part of the full size heat exchanger module. The successful operation for seven hours of the full size ceramic heat exchanger test module above 1150°C (2100°F) outlet temperatures at 689 kPa (100 psi) with firing temperatures at 1370°C (2500°F) demonstrates the potential of pressurized ceramic heat exchangers. The design operated without major problems and demonstrated the viability of the design's thermal shock capabilities and the design repairability.

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 30740, 30853

30908 (CONF-800647—7) **Investigation of hydrogen and chlorine at the SiO_2/Si interface.** Tsong, I.S.T.; Monkowski, M.D.; Monkowski, J.R.; Miller, P.D.; Moak, C.D.; Appleton, B.R.; Wintenberg, A.L. (Pennsylvania State Univ., University Park (USA); Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 6p. NTIS, PC A02/MF A01.

From International conference on the physics of MOS insulators; Raleigh, NC, USA (18 Jun 1980).

Silicon oxides thermally grown in H_2O, O_2, HCl/O_2 and Cl_2/O_2 ambients were analyzed, via $^1H(^{19}F,\alpha\gamma)^{16}O$nuclear reaction and SIMS, for the presence of hydrogen. In addition, those oxides grown in HCl/O_2 and Cl_2/O_2 ambients were analyzed with SIMS for the presence of chlorine. The SIMS data show that the hydrogen levels in these oxides were below the limit of detection for nuclear reaction experiments. The $^{35}Cl^+$ depth-profiles show that chlorine is enriched at the SiO_2 interface for the HCl/O_2 grown oxides while it is more evenly distributed in oxide bulk in the Cl_2/O_2 grown samples.

30909 **Performance of ThO_2-UO_2 fuel in Indian Point I.** Kerr, J.M.; Jones, H.M.; Baroch, C.J.; Silk, E.J. (Babcock & Wilcox Co., Lynchburg, VA). Contract AT(30-1)-3809. *Am. Ceram. Soc. Bull.;* **59**: No. 6, 606-610(Jun 1980).

From 31. Pacific Coast regional meeting of the American Ceramic Society; San Diego, CA (USA) (27 Oct 1978).

Indian Point I, a pressurized water reactor designed and built by the Babcock & Wilcox Co. and operated by the Consolidated Edison Co. of New York from September 1962 until October 1965, had a first core of stainless-steel-clad ThO_2-UO_2 pellets. This core operated successfully for 442 effective full power days at peak fuel burnups as high as 33 000 MWd/T and generated 2.8 billion kWh of electricity. The fuel pellets (nominally 93% of theoretical density) showed little or no degradation and no major microstructural changes. The fuel was fabricated using mechanical mixing, cold pressing, and sintering. The specific fuel fabrication flow sheet, core design, and postirradiation examination of the fuel are described.

30910 Characterization of high field varistors in the system ZnO-CoO-PbO-Bi_2O_3. Snow, G.S.; White, S.S.; Cooper, R.A.; Armijo, J.R. (Sandia Labs., Albuquerque, NM). *Am. Ceram. Soc. Bull.;* **59**: No. 6, 617-622(Jun 1980).

From 80. annual meeting of the American Ceramic Soceity; Detroit, MI (USA) (8 May 1978).

High field varistors ($10<E<60$ kV/cm at J $\simeq$ 10 A/cm^2) with large nonlinearity coefficients ($\alpha>20$) were fabricated in the system ZnO-CoO-PbO-Bi_2O_3 by hot pressing and by pressureless-sintering techniques. These varistor compositions are particularly suitable for applications at high current densities ($J>1$ A/cm^2) where the nonlinearity coefficients reach maximum values. Variations in electrical properties with processing and composition are described.

30911 Hot press with flat plate heaters and its application to the fabrication of large varistor slugs. Snow, G.S.; Cooper, R.A. (Sandia Labs., Albuquerque, NM). *Am. Ceram. Soc. Bull.;* **59**: No. 5, 550-551(May 1980).

A hot press was designed and constructed for fabricating large ZnO varistor slugs. The electrical properties of ZnO varistors containing CoO, PbO, and Bi_2O_3 are very dependent on processing temperature. To fabricate varistors with the desired field (E = 42.5 +- 1.5 kV/cm at 5 A/cm^2), it was necessary to maintain temperature uniformity within +- 3.5°C throughout the slug and from run to run. The slugs were fabricated in the form of disks $\simeq$ 75 mm in diameter with a final thickness of $\simeq$ 14 mm. Ceramics have been hot pressed previously using apparatus in which the heat source was in the form of a cylinder surrounding, and coaxial to, the slug. Unless the heat source is long compared with its diameter, such a heating method results in poor temperature uniformity, which is aggravated by poor thermal coupling with the heat source and by large heat losses through the pushrods. In the design described herein, these problems are avoided by using flat plate heaters above and below the slug.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 30909, 30926

30912 (CONF-800647—4) Periodic structural models and radial distribution functions of SiO/sub x/: x = 0. to 2. Ching, W.Y. (Missouri Univ., Kansas City (USA). Dept. of Physics). 1980. Contract AC02-79ER10462. 16p. NTIS, PC A02/MF A01.

From International conference on the physics of MOS insulators; Raleigh, NC, USA (18 Jun 1980).

A series of random network structural models with periodic boundary conditions for SiO/sub x/ for x range from 0. (pure amorphous Si) to 2. (pure vitreous silica) within the context of microscopic random bond mixing model have been constructed. A Keating type of potential is used in the computer relaxation process. These cubic models which have 54 Si atoms and variable number of O atoms have no internal voids or dangling bonds. Each O atom binds to two Si atoms in a non-linear bridging position while each Si atom binds to four other atoms (Si or O) in a tetrahedral configuration. The densities, radial distribution functions (RDF) and partial RDF are studied as a function of x and are compared with available x-ray scattering data. It is found that for cases of x not equal to 0. or 2., the Si-Si bond lengths tend to be larger and Si-O bond lengths tend to be shorter than their respective crystalline bond lengths. Utilization of these structural models in the electronic and vibrational calculations is also discussed.

30913 (DOE/ER/01198—1308) Panel report on high temperature ceramics. Nolet, T.C. (ed.). (Illinois Univ., Urbana (USA). Materials Research Lab.). Jan 1979. Contract AC02-76ER01198. 163p. NTIS, PC A08/MF A01.

Fundamental research is reported concerning high temperature ceramics for application in turbines, engines, batteries, gasifiers, MHD, fuel cells, heat exchangers, and hot wall combustors. Ceramics microstructure and behavior are included. (FS)

30914 Thermal gradient migration of lenticular voids. Nichols, F.A. (Argonne National Lab., IL (USA)). *J. Nucl. Mater.;* **84**: No. 1-2, 319-326(Oct 1979).

Available data on the velocity of gas-filled lenticular void motion in oxides subjected to a thermal gradient have been evaluated. Excellent agreement is found with a theoretical model based on vapor-diffusion control. Equilibrium vapor pressure is assumed to be maintained at the pore surface and the actual local thermal gradient, as determined by pore shape and relative thermal conductivity, is employed. The quantitative success of the theory in spite of the 'flat' void surfaces is especially significant and raises serious questions concerning the practice of some authors in assuming, a priori, that a 'flat' interface implies 'interfacial control'.

30915 (SAND—80-0729C) Optical image storage in ion implanted PLZT ceramics. Peercy, P.S.; Land, C.E. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 29p. (CONF-800744—1). NTIS, PC A03/MF A01.

From Ion beam modification of materials conference; Albany, NY, USA (14 Jul 1980).

Optical images can be stored in transparent lead-lanthanum-zirconate-titanate (PLZT) ceramics by exposure to near-uv light with photon energies greater than the band gas energy of ~ 3.35 eV. The image storage process relies on optically induced changes in the switching properties of ferroelectric domains (photoferroelectric effect). Stored images are nonvolatile but can be erased by uniform uv illumination and simultaneous application of an electric field. Although high quality images, with contrast variations of $\geq$ 100:1 and spatial resolution of ~ 10 μm, can be stored using the photoferroelectric effect, relatively high exposure energies (~ 100 mJ/cm^2) are required to store these images. This large exposure energy severely limits the range of possible applications of nonvolatile image storage in PLZT ceramics. It was found in H, He, and Ar implanted PLZT that the photosensitivity can be significantly increased by ion implantation into the surface to be exposed. The photosensitivity after implantation with 5 x 10^{14} 500 keV Ar/cm^2 is increased by about three orders of magnitude over that of unimplanted PLZT. The image storage process and the effect of ion implantation is presented along with a phenomenological model which describes the enhancement in photosensitivity obtained by ion implantation. This model takes into account both light- and ion implantation-induced changes in conductivity and gives quantitative agreement with the measured changes in the coercive voltage with light intensity for ion implanted PLZT.

30916 (SAND—80-0823C) Ion-implantation-induced phase separation and crystallization in lithia-silica glasses. Arnold, G.W.; Peercy, P.S.; Doyle, B.L. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 26p. (CONF-800744—5). NTIS, PC A03/MF A01.

From Ion beam modification of materials conference; Albany, NY, USA (14 Jul 1980).

Crystallization of annealed $Li_2O.2SiO_2$ glasses implanted with inert ions and fused SiO_2 glass implanted with Li ions was monitored using infrared reflection spectroscopy. Elastic recoil detection analysis was used to study changes in the Li and H concentration induced in these glasses by implantation and annealing. Implantation of $Li_2O.2SiO_2$ with inert ions results in Li depletion, accompanied by H indiffusion, in the implanted region. For Li-implanted SiO_2, crystallization of α-quartz is accompanied by appreciable Li diffusion to the surface and attendant H migration to the Li-depleted region. The crystallization mechanisms are discussed in terms of phase separation in the lithia-silica system.

30917 Observation of the amorphous-to-crystalline surface transition in Al-Al/sub x/O/sub y/ using slow positrons. Lynn, K.G. (Brookhaven National Laboratory, Upton, New York 11973). EY-76-C-02-0016. *Phys. Rev. Lett.;* **44**: No. 20, 1330-1333(19 May 1980).

The amorphous-to-crystalline surface transition of Al/sub x/O/sub y/ on the Al(111) surface is observed between 650 and 800 K with different O_2 exposures by measuring the positronium (Ps) fraction produced by e^+ impinging on the surface. The data are interpreted in terms of vacancy-type defects in the film or at the metal—metal-oxide interface which act as trapping sites for e^+ or Ps. As the ordering process proceeds to completion the trapping centers anneal out and the Ps fraction increases, showing an irreversible transition. This technique provides a new experimental method to study interfaces.

30918 Deep trapping states for hydrogen in deformed iron. Kumnick, A.J.; Johnson, H.H. (Cornell Univ., Ithaca, NY). *Acta Metall.;* **28**: No. 1, 33-39(Jan 1980).

Hydrogen trapping in deformed iron was studied by time lag measurements based upon gas phase charging and electrochemical measuring techniques. A trap binding energy of 14.3 +- 1.1 kcal mol ^{1}H(59.9 +- 4.6 kJ mol^{-1} H) was determined. Trap densities varied from just under 10^{20} m^{-3} for annealed iron to a little over 10^{23} m^{-3} for heavily deformed iron. The traps are believed to be associated with the imperfection structure, dislocations and/or dislocation debris, developed during plastic deformation.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 30913, 30940

30919 (GA-A—15805) **Characterization of thermally sprayed coatings for high-temperature wear-protection applications.** Li, C.C. (General Atomic Co., San Diego, CA (USA)). Mar 1980. Contract AT03-76ET35300. 44p. (CONF-800439—2). NTIS, PC A03/MF A01.

From International conference on metallurgical coatings; San Diego, CA, USA (21 Apr 1980).

Under normal high-temperature gas-cooled reactor (HTGR) operating conditions, faying surfaces of metallic components under high contact pressure are prone to friction, wear, and self-welding damage. Component design calls for coatings for the protection of the mating surfaces. Anticipated operating temperatures up to 850 to 950°C (1562 to 1742°F) and a 40-y design life require coatings with excellent thermal stability and adequate wear and spallation resistance, and they must be compatible with the HTGR coolant helium environment. Plasma and detonation-gun (D-gun) deposited chromium carbide-base and stabilized zirconia coatings are under consideration for wear protection of reactor components such as the thermal barrier, heat exchangers, control rods, and turbomachinery. Programs are under way to address the structural integrity, helium compatibility, and tribological behavior of relevant sprayed coatings. In this paper, the need for protection of critical metallic components and the criteria for selection of coatings are discussed. The technical background to coating development and the experience with the steam cycle HTGR (HTGR-SC) are commented upon. Coating characterization techniques employed at General Atomic Company (GA) are presented, and the progress of the experimental programs is briefly reviewed. In characterizing the coatings for HTGR applications, it is concluded that a systems approach to establish correlation between coating process parameters and coating microstructural and tribological properties for design consideration is required.

30920 **Deformation and failure caused by grain boundary sliding and brittle cracking.** Evans, A.G. (Univ. of California, Berkeley). *Acta Metall.;* **28**: No. 8, 1155-1164(Aug 1980).

A failure mechanism which entails grain boundary sliding and brittle crack extension along grain boundaries is analyzed. It is demonstrated that the crack growth, which occurs above a threshold stress, is dictated by the grain boundary viscosity, fracture energy, the grain facet length, and the boundary orientations vis-a-vis the applied stress. The time taken to form a stable facet-sized crack is derived, and shown to be non-linear in the applied stress. The creep strains that result from this mode of cracking are generally small and non-linear.

30921 **Crack tip dislocations in MgO.** Majumdar, B.S.; Burns, S.J. (Univ. of Rochester, NY). Contract DE-AS02-76ER02422. *Scr. Metall.;* **14**: No. 6, 653-656(Jun 1980).

Several dislocation free zones were shown at crack tips. It is proposed that these zones are free of dislocations because of image forces with the stress free crack surfaces. Dislocations that are nucleated at the crack tip would be looped around or on one side of the crack tip. When the crack moves these dislocations would be annihilated by the crack tip at distances less that $r_0/4$. The material between r_0 and the crack tip is elastic because it is dislocation free - which is even a stronger condition than the recent fracture theories require.

30922 (SAND—80-6009) **First all-union symposium on shock pressures, October 24-26, 1973, Moscow. Volume 2.** Batsanov, S.S. (ed.). (Vsesoyuznyj Nauchno-Issledovatel'skij Inst. Fiziko-Tekhnicheskikh i Radiotekhnicheskikh Izmerenij, Moscow (USSR)). Apr 1980. Translation of Doklady i vsesoyuznogo simpoziuma po impul'snym davleniyam, Tom 2. 141p. NTIS, PC A07/MF A01.

Portions of document are illegible.

Twenty-two papers on the chemistry of impulsive pressures are contained in this volume. The papers deal primarily with shock wave propagation in various materials (particularly oxides) and explosive forming and sintering. (RWR)

30923 **High temperature failure mechanisms in ceramics.** Evans, A.G.; Rana, A. (Univ. of California, Berkeley). Contract W-7405-ENG-48. *Acta Metall.;* **28**: No. 2, 129-141(Feb 1980).

A statistical model of high temperature failure in ceramics, by the viscous or diffusive growth of cavities, has been developed. General expressions for the creep strain associated with cavitation and for the failure time have been derived, and shown to be in good agreement with available data. Specific models of cavity growth along grain facets, by diffusive and viscous mechanisms, have then been generated, and coupled with the statistical model: to provide specific predictions of the creep strain and the failure time. The predictions are in reasonable accord with experimental results.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 30788, 30873, 30908, 30910, 30913, 30915, 30945

30924 (SAND—80-0251C) **Trapping, detrapping, and replacement of keV hydrogen implanted into graphite.** Roth, J.; Scherzer, B.M.U.; Blewer, R.S.; Brice, D.K.; Picraux, S.T.; Wampler, W.R. (Association Euratom-Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.); Sandia Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 22p. (CONF-800455—17). NTIS, PC A02/MF A01.

From 4. international conference on plasma surface interactions in controlled fusion devices; Garmisch, F.R. Germany (21 Apr 1980).

Trapping and detrapping of low energy hydrogen isotopes in graphite is relevant to the collection of fuel particles in graphite probes for diagnostics of particle fluxes and energies in the plasma boundary layer, and to the recycling of fuel particles. The measurement of saturation concentrations by α profiling of D may be influenced by detrapping of deuterium by the analyzing ^{3}He-beam.

30925 **Comments on 'High-temperature thermodynamic properties of the UCsub(1 → 2) phase'; and reply by McLellan, R.B.** Murch, G.E. (Argonne National Lab., IL (USA)). *J. Phys. Chem. Solids;* **41**: No. 4, 411-412(1980).

30926 **Enthalpy of sodium silicate glasses and liquids.** Eliezer, I.; Eliezer, N.; Howald, R.A.; Verwolf, M.C.; Viswanadham, P. (Montana State Univ., Bozeman). *Calphad;* **3**: No. 1, 1-8(1979).

The enthalpy data of Hummel and Schwiete (1) for sodium silicate glasses at 298.15°K have been fitted by power series in the mole fraction. It is shown that four coefficients provide an excellent fit of the data (X_1 = .1818 to .6667) but five are required for a reasonable extrapolation to pure $NaO_{.5}$(X_1=1). If estimates for the partial molal enthalpy of SiO_2 are included in the least squares, the equation also extrapolates well to pure SiO_2. Combining these values with the expressions for the excess heat capacity of mixing (2) and known solubility data (3,4) for the binary system, one obtains a consistent set of coefficients for the calculation of enthalpies and activities at any temperature and composition. The $NaO_{.5}$-SiO_2 phase diagram calculated from these values is shown.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 30741, 30788, 30908

30927 (BM-RI—8430) **High-temperature corrosion resistance of alumina refractories to lignite ash slags.** Pahlman, J.E.; Anderson, C.F.; Khalafalla, S.E. (Bureau of Mines, Pittsburgh, PA (USA)). 1979. 24p. Dept. of Interior, Pittsburgh, PA.

As part of its goal to minimize the requirements for mineral commodities through conservation and substitution, the Bureau of Mines is conducting research to determine the resistance of alumina refractories to corrosion by alkali-containing slags that could result from burning of the abundant Western lignites in metallurgical operations. Static corrosion tests were performed at 1000 to 1350°C and dynamic tests were performed at 1400 to 1600°C to investigate the stability of refractory specimens in slag environments. In general, the degree of refractory attack increased with decreasing alumina content in the refractory and with increasing alkali content of the lignite ash. The parabolic kinetics observed in static tests suggested that a reaction product layer is formed through which ionic diffusion must occur to sustain the reaction with the refractory material. The linear kinetics observed in dynamic tests in high-viscosity slags indicated a shearing of the reaction product layer by viscous slags. The observed lesser attack of refractories by low-viscosity slags can be explained on this basis. Two 99-percent-alumina refractories and two 90-percent-alumina refractories formed an expanded protective layer with the more viscous slags but not with the less viscous slags. Corrosion of 90-percent-alumina refractories increased exponentially with temperature. In refractories with the same nominal alumina content, those that contain a combination of α-Al_2O_3 and mullite ($3Al_2O_3.2SiO_2$) have better corrosion resistance than those containing a combination of α-Al_2O_3, cristobalite (SiO_2 mineral), and mullite. In alkali environments (1300 to 1400°C), 90- to 99-percent-alumina refractories are recommended for use as furnace linings.

30928 (FE—2708-8) **Stability of SiC, Si_3N_4, Si_2N_2O SIALON and chromium oxide-containing refractories in coal gasification environments. Second annual report, September 1, 1978-August 3, 1979.** Muan, A. (Pennsylvania State Univ., University Park (USA). Coll. of Earth and Mineral Sciences). 15 Oct 1979. Contract EF-77-S-01-2708. 25p. NTIS, PC A02/MF A01.

The main conclusions are as follows: (1) the corrosive action of coal-ash slags on SiC refractories is caused mainly by the reduction-oxidation reaction between SiC and the iron oxide component of the slag; (2) the rate of attack on SiC by coal-ash slag is critically dependent on temperature, i.e., whether or not the SiC-slag interface is above or below the solidus temperature of the silicates involved (as a first approximation selected compositions in the system CaO-FeO-Al_2O_3-SiO_2). This temperature is ~ 1100°C; and (3) studies of equilibrium relations in selected chromium oxide-containing silicate

systems have established the low solubility of Cr_2O_3-containing refractory phases in silicate melts. The solubility of these phases in slicate melts increases drastically, however, at extremely low oxygen pressures, under which conditions a substantial fraction of the chromium is present in the silicate liquid as Cr^{2+}. The oxygen pressures at which this situation prevails, however, are somewhat lower than those prevailing in coal gasification atmospheres.

30929 (MLM—2730) **$^{238}PuO_2$/Mo-50 wt% Re compatibility at 800 and 1000°C.** Schaeffer, D.R.; Teaney, P.E. (Mound Facility, Miamisburg, OH (USA)). 18 Jul 1980. Contract AC04-76DP00053. 21p. NTIS, PC A02/MF A01.

The compatibility of Mo-50 wt % Re with $^{238}PuO_2$ was investigated after heat treatments of up to 720 days at 800°C and 180 days at 1000°C. At 800°C, a 1-μm thick, continuous layer of molybdenum oxide resulted. At 1000°C, the oxide reaction product contained some plutonium and did not appear continuous. At 1000°C, a layer of intermetallic formed at the Mo-Re edge, beneath the oxide layer, creating a barrier between the Mo-50 wt % Re and the $^{238}PuO_2$. The intermetallic layer was promoted by the iron impurity in the $^{238}PuO_2$.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 30271, 30671

30930 Transmission electron microscopy study of the defect microstructure of Al_2O_3 subjected to ion bombardment. Rechtin, M.D. (Argonne National Lab., IL (USA)). *Radiat. Eff.;* **42**: No. 3-4, 129-144(Sep 1979).

The defect microstructure induced in single-crystal aluminium oxide by bombardment with high-energy ions has been studied by transmission electron microscopy (TEM). The effects of the irradiation temperature, the type of ion used for irradiation, and the presence of inert gas atoms upon the microstructure were examined in detail. The intrinsic, displacement-induced defect structures which resulted from ion bombardment appeared quite similar to the microstructures of aluminium oxide subjected to fast neutron or high energy electron irradiation at similar temperatures and doses. The most significant changes in the microstructure were caused by bombardment with helium ions. Implantation of helium into alumina at low temperature followed by annealing at high temperature resulted in the formation of a dense dislocation network. The large number of defects required to account for this network may have arisen from strong trapping of helium by radiation-induced vacancies, which left a large population of interstitials to collect into loops.

COMPOSITE MATERIALS

REFER ALSO TO CITATION(S) 30103

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 30845

MECHANICAL PROPERTIES

30931 (CONF-800393—1) **Advances in nondestructive evaluation methods for inspection of refractory concretes.** Ellingson, W.A. (Argonne National Lab., IL (USA)). 1980. Contract W-31-109-ENG-38. 27p. NTIS, PC A03/MF A01.

From Symposium on premature failure in monolithic refractory constructions: preventive and remedial treatment; Las Vegas, NV, USA (2 Mar 1980).

Refractory concrete linings are essential to protect steel pressure boundaries from high-temperature agressive erosive/corrosive environments. Castable refractory concretes have been gaining more acceptance as information about their performance increases. Economic factors, however, have begun to impose high demands on the reliability of refractory materials. Advanced nondestructive evaluation methods are being developed to assist the refractory user. Radiographic techniques, thermography, acoustic-emission detection, and interferometry have been shown to yield information on the structural status of refractory concrete. Methods using ^{60}Co radiation sources are capable of yielding measurements of refractory wear rate as well as images of cracks and/or voids in pre- and post-fired refractory linings up to 60 cm thick. Thermographic (infrared) images serve as a qualitative indicator of refractory spalling, but quantitative measurements are difficult to obtain from surface-temperature mapping. Acoustic emission has been shown to be a qualitative indicator of thermomechanical degradation of thick panels of 50 and 95% Al_2O_3 during initial heating and cooling at rates of 100 to 220°C/h. Laser interferometry methods have been shown to be capable of complete mappings of refractory lining thicknesses. This paper will present results obtained from laboratory and field applications of these methods in petrochemical, steel, and coal-conversion plants.

CORROSION, EROSION, AND DEGRADATION

REFER ALSO TO CITATION(S) 30931

POLYMERS AND PLASTICS

30932 (BDX—613-2432) **Bonding silicones with epoxies.** Tira, J.S. (Bendix Corp., Kansas City, MO (USA)). 1980. Contract AC04-76DP00613. 13p. (CONF-800450—3). NTIS, PC A02/MF A01.

From Annual adhesive conference; St Petersburg, FL, USA (29 Apr 1980).

It is shown that silicones, both room temperature vulcanizing (RTV) and millable rubber (press cured) can be successfully bonded to other materials using plasma treatment and epoxy adhesives. The plasma treatment using dry air atmosphere increases the surface energy of the silicone and thus provides a lower water contact angle. This phenomenon allows the epoxy adhesive to wet the silicone surface and ultimately bond. Bond strengths are sufficiently high to result in failures in the silicone materials rather than the adhesive bond.

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 30169, 30938

30933 (BDX—613-2422) **Multilayer printed wiring board lamination.** Lula, J.W. (Bendix Corp., Kansas City, MO (USA)). Jun 1980. Contract AC04-76DP00613. 25p. NTIS, PC A02/MF A01.

The relationship of delamination resistance of multilayer PWBs made from GF material to manufacturing process variables was investigated. A unique quantitative test method developed during this project shows that delamination resistance is highly sensitive to material conditioning, to innerlayer surface treatment, and to post-lamination storage conditions, but is relatively insensitive to cure cycle variations.

STRUCTURE AND PHASE STUDIES

30934 (DOE/ER/04440—7) **Diffusion mechanisms and degradation of environmentally sensitive composite materials. Progress report, July 1, 1979-June 30, 1980.** Broutman, L.J. (Illinois Inst. of Tech., Chicago (USA)). Apr 1980. Contract AS02-77ER04440. 15p. NTIS, PC A02/MF A01.

Progress not previously discussed in reports COO-4440-4 through COO-4440-6 is summarized. Moisture diffusion results in unstressed epoxy samples obtained last year (below 70°C) suggested the presence of a 2-phase structure in the cured epoxy resin. Chemical etching studies initiated this year further confirm the existence of this structure. Also, diffusion results obtained at 95°C demonstrate a reversal in the trend of diffusivity versus crosslink density as observed on the same samples last year. A damage mechanism at this temperature is proposed to explain the results. Initial results on stressed epoxy samples show the inadequacy of the current test fixtures; as a result, new fixtures have been designed to eliminate stress relaxation problems due to swelling and creep of the resin samples during the experiment.

30935 Kinetics of the II-III phase transformation of polytetrafluoroethylene at high pressure. Nicol, M.F.; Wiget, J.M.; Wu, C.K. (Univ. of California, Los Angeles). Contract E(04-3)34,PA88. *J. Polym. Sci., Polym. Phys. Ed.;* **18**: No. 5, 1087-1102(May 1980).

The rate of transformation from helical to all-trans-planar polytetrafluoroethylene (PTFE) at high pressures has been determined by monitoring the Raman spectra of PTFE following pressure jumps from the stability field of PTFE II to pressures between 9 and 14 kbar at temperatures between 0 and -30°C. The transformation kinetics can be described by Avrami's equation for nucleation and growth kinetics with an exponent of 0.5, although observations at lower temperatures suggest that even smaller values of the exponent may be appropriate. At 10 kbar and 0°C, the specific rate constant is 0.51 min/sup -1/2. The energy and volume of activation are 11 kcal mole/sup -1/ and-7 cm^3 mole/sup -1/ respectively. The values of these parameters suggest that the transformation mechanism involves propagation of helix reversal planes along the several adjacent chains leaving all-trans material in their wakes. 10 figures, 2 tables.

MECHANICAL PROPERTIES

30936 (BDX—613-2405) **Test methods for the dynamic mechanical properties of polymeric materials. Final report.** Baker, G.K.

(Bendix Corp., Kansas City, MO (USA)). Jun 1980. Contract AC04-76DP00613. 73p. NTIS, PC A04/MF A01.

Various test geometries and procedures for the dynamic mechanical analysis of polymers employing a mechanical spectrometer have been evaluated. The methods and materials included in this work are forced torsional pendulum testing of Kevlar/epoxy laminates and rigid urethane foams, oscillatory parallel plate testing to determine the kinetics of the cure of VCE with Hylene MP, oscillatory compressive testing of B-3223 cellular silicone, and oscillatory tensile testing of Silastic E and single Kevlar filaments. Fundamental dynamic mechanical properties, including the storage and loss moduli and loss tangent of the materials tested, were determined as a function of temperature and sometimes of frequency.

30937 (BDX—613-2408) **Phenolic resin syntactic foams.** McIlroy, H.M. (Bendix Corp., Kansas City, MO (USA)). Jun 1980. Contract AC04-76DP00613. 21p. NTIS, PC A02/MF A01.

Syntactic foams were prepared from blends of six phenolic resins and carbon microbubbles. The compressive strength of the phenolic resin foams is equivalent to the strength of foams made from a polyimide resin. Ammonia evolved during the cure diffuses rapidly and is not bound by the foam.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 30937

30938 (BDX—613-2354) **Evaluation of improved polyamides.** Hishaw, R.J. (Bendix Corp., Kansas City, MO (USA)). Jun 1980. Contract AC04-76DP00613. 22p. NTIS, PC A02/MF A01.

Three polyamides, nylon 11, nylon 12, and a transparent nylon, were evaluated by physical testing, characterization and analytical methods, and injection molding. None of the materials proved to be clearly superior to the others. Results of the evaluation will be used to determine applications for the materials in future production programs.

30939 (BDX—613-2394) **Moisture penetration evaluation of polystyrene bead foam as an encapsulant for electronic packages.** Swanson, G.D. (Bendix Corp., Kansas City, MO (USA)). Jun 1980. Contract AC04-76DP00613. 19p. NTIS, PC A02/MF A01.

Discs of polystyrene bead foam were used to measure resistance to high-pressure moisture penetration. Densities of 0.2, 0.3, 0.4, 0.5, and 0.6 g/cm^3 processed at various fusion times and temperatures were tested. Only three fusion conditions for 0.6 g/cm^3 density were impervious to moisture penetration at 1724 kPa for 24 hours or more.

OTHER MATERIALS

30940 (UCID—18574-80-1) **H-Division quarterly report, January-March 1980.** (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1980. Contract W-7405-ENG-48. 64p. NTIS, PC A04/MF A01.

The following research projects were in progress in H Division of the LLL Physics Department during the quarter January to March 1980: Theoretical EOS Group - three-phase EOS model for the H isotopes, development of CHEQ and fluid-fluid phase separations in the inert gases, release-velocity calculations, mixing rule for the EOS of binary ionic mixtures; Experimental Physics Group - progress of the laser EOS program, performance optimization of the two-stage light-gas gun, properties of materials at high pressure; Fluid Physics Group - research on fundamental mechanisms of turbulent gas/solid erosion, triple-point viscosities of the Lennard-Jones fluid, soft-mode instability in Hooke's Law crystals; Applied Physics/Code Development Group - cavity dynamics in the HYLIFE inertial-confinement fusion reactor, equation of state of aluminum nitride powder for explosive compaction. Detailed individual reports on completed work may be expected. 25 figures, 3 tables. (RWR)

PREPARATION AND MANUFACTURE

REFER ALSO TO CITATION(S) 30376, 30377, 30378, 30386, 30391, 30392, 30393, 30394, 30395, 30396, 30856

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 30311, 30312, 30398, 30856

30941 **Brillouin scattering in the layer compound GaSe.** Chiang, T.C.; Dumas, J.; Shen, Y.R. (Univ. of California, Berkeley). *Solid State Commun.;* **28**: No. 2, 173-176(1978).

Brillouin scattering has been used to obtain the five independent elastic constants in the layer compound GaSe. The results show clear elastic anisotropy of the crystal. Resonant Brillouin scattering near the absorption edge has also been studied, but no resonant enhancement was found.

PROPERTIES

REFER ALSO TO CITATION(S) 30312, 30799, 30941, 31090

30942 **Charge-density variation in a model of amorphous silicon.** Guttman, L.; Ching, W.Y.; Rath, J. (Solid State Science Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev. Lett.;* **44**: No. 23, 1513-1516(9 Jun 1980).

A population analysis of the one-electron eigenfunctions of random-network models of amorphous silicon shows fluctuations of the net atomic charge of about 0.2 electron units rms. The majority of the charge is calculable from a linear function of the deviations of first-neighbor distance and of interbond angle from their values in the crystal.

30943 **Neutron scattering study of spin dynamics in $CsCoCl_3$.** Satija, S.K.; Shirane, G.; Yoshizawa, Y.; Hirakawa, K. (Brookhaven National Laboratory, Upton, New York 11973). DE-AC02-79CH00016. *Phys. Rev. Lett.;* **44**: No. 23, 1548-1551(9 Jun 1980).

Neutron profiles of spin waves in the 1d Ising-like antiferromagnet $CsCoCl_3$ were reexamined. Instead of well-defined magnon peaks, the spin-wave spectrum consists of a band of magnon states arising from the motion of domain-wall pairs. At the magnetic zone center, the energy of this band extends from $2J(1-2\epsilon)$ to $2J(1+2\epsilon)$, whereas at the zone boundary a sharp resolution limited peak at $\omega \sim 2J$ is observed.

30944 **Interaction of NaCl with limestones during calcination.** Shearer, J.A.; Johnson, I.; Turner, C.B. (Argonne National Lab., IL). *Am. Ceram. Soc. Bull.;* **59**: No. 5, 521-524, 528(May 1980).

The interaction of small quantities of NaCl with limestone during calcination is shown to increase the average pore diameters of the lime particles. For twenty-eight limestones pore diameters increased from an overall average of 0.14 to 1.8 μm for 2.0 wt % NaCl addition. These structural changes are thought to result from the formation of trace amounts of liquid phase at high temperatures, which increases the ionic diffusion of the system. Controlled use of salt additives can result in a pore structure favorable to subsequent reactions involving gas or liquid phases. The effectiveness of the salt addition in promoting changes in pore distribution is dependent on the impurity content of the original limestone.

30945 **Simplification of thermodynamic calculations through dimensionless entropies.** Pitzer, K.; Brewer, L. (Univ. of California, Berkeley). *High Temp. Sci.;* **11**: No. 1, 49-53(Mar 1979).

Where dimensionless quantities determine the behavior of physical systems, there are many advantages in tabulating data in the form either of these same dimensionless quantities or of quantities as closely related thereto as feasible. There are opportunities in chemical thermodynamics and statistical mechanics to simplify calculations and to increase understanding by changes of this sort. In particular the thermodynamic behavior is determined by the interplay of two factors, each dimensionless. First is the a priori probability of various states, while the second category comprises the ratios of energy differences to thermal energy at the temperature of interest. The probability ratios (W/sub J/W/sub i/) are dimensionless and take on dimensions only when expressed as entropes by the relationship $\Delta S = R \ln (W/\text{sub } j//W/\text{sub } i/)$. There are practical as well as conceptual advantages in the use of the dimensionless form (S/R) in tabulating entropy data.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 30271

30946 **Model for nonequilibrium segregation during pulsed laser annealing.** Wood, R.F. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). W-7405-ENG-26. *Appl. Phys. Lett.;* **37**: No. 3, 302-304(1 Aug 1980).

Highly nonequilibrium thermodynamic processes occur during the ultrarapid recrystallization characteristic of pulsed laser annealing. Values of interface segregation coefficients are observed to differ from equilibrium values by as much as three orders of magnitude and equilibrium solubility limits may be exceeded by similar magnitudes. In this letter, a model is developed which accounts quantitatively for these effects.

CHEMISTRY

ANALYTICAL AND SEPARATIONS CHEMISTRY

REFER ALSO TO CITATION(S) 30327, 30335, 30742, 30974

30947 (FE—2710-7) **Instrumental analysis of sulfur compounds in coal process streams. Quarterly technical progress report, April-July 1979.** Jordan, J. (Pennsylvania State Univ., University Park (USA). Dept. of Chemistry). Jul 1979. Contract EF-77-S-01-2710. 25p. NTIS, PC A02/MF A01.

Sulfate and thiosulfate yielded well-defined differential pulse polarograms at the dropping mercury electrode, corresponding to the anodic depolarization process. Differential pulse voltammetry of benzothiophene at a rotated glassy carbon disk anode yielded peak signals which were proportional to concentration in a range between 4×10^{-5} M and 2×10^{-3} M. Injection of bisulfide samples into an excess of the reagent hydroxymercury benzoate produced temperature increments which provided a linear measure of HS^- concentration in a range between 50 and 5000 ppM. The feasibility of the determination of SO_2 by differential pulse voltammetry at a rotated glassy carbon cathode has been demonstrated in Synthane by-product waste water samples. Interfering sulfides were successfully removed by prior precipitation as CdS. Tridimensional Pourbaix Diagrams have been applied to predict mole fractions of the sulfur moieties H_2S, HS^-, S^{--}, SO_2, HSO_3^-, SO_3^{--}, HSO_4^- and SO_4^{--} in four (4) process stream samples. The hypothetical assignments were drastically at variance with the experimentally measured concentration ratios, indicating that thermodynamic equilibrium was not attained in the process streams.

30948 (ORNL—5619) **Analytical Chemistry Division annual progress report for period ending December 31, 1979.** Shults, W.D.; Lyon, W.S. (ed.). (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 165p. NTIS, PC A08/MF A01.

The progress is reported in the following sections: analytical methodology, mass and emission spectrometry, technical support, bio-organic analysis, nuclear and radiochemical analysis, and quality assurance. (DLC)

30949 **Pattern recognition by audio representation of multivariate analytical data.** Yeung, E.S. (Ames Lab., IA). W-7405-ENG-82. *Anal. Chem.;* **52**: No. 7, 1120-1123(Jun 1980).

We present an objective recipe, based on the statistical distribution of data on each axis in k-dimensional space, for audio display of multivariate analytical data. Each measurement in the data vector is translated into an independent property of sound. Scaling is performed in a continuous manner. The case for $k \leq 9$ is treated here, but it should be possible to approach $k = 20$ with slight loss of resolution and with somewhat increased risk of non-orthogonality. A significant feature of such a presentation of analytical data is that good acoustical standards are available so that the trained ear can associate each sound with a good estimate of the value in the original measurement. Excellent results were obtained when this method was applied to the pattern recognition of a test data set. Advantages over visual (graphical) representation schemes are discussed.

ACTIVATION AND NUCLEAR REACTION PROCEDURES

REFER ALSO TO CITATION(S) 30235, 30398, 30972

30950 (HEDL-SA—1702-FP) **Experimental ^{233}U nondestructive assay with a random driver.** Goris, P. (Hanford Engineering Development Lab., Richland, WA (USA)). 1979. Contract AC14-76FF02170. 16p. (CONF-791117—28). NTIS, PC A02/MF A01.

From ANS topical conference; Kiawah Island, SC, USA (26 Nov 1979).

Nondestructive assay (NDA) of ^{233}U in quantities up to 15 grams containing 7 ppM ^{232}U age 2 years was investigated with a random driver. A passive singles counting technique showed a reproducibility within 0.2% at the 95% confidence level. This technique would be applicable throughout a process in which all of the ^{233}U had the same ^{232}U content at the same age. Where the ^{232}U content varies, determination of ^{233}U fissile content would require active NDA. Active coincidence counting utilizing a ^{238}Pu, Li neutron source and a plastic scintillator detector system showed a reproducibility limit within 15% at the 95% confidence limit. The active technique was found to be very dependent on the detector system resolving time in order to make proper random coincidence corrections associated with the high gamma activity from the ^{232}U decay chain.

30951 **Concentrations of elements in the national bureau of standards' bituminous and subbituminous coal standard reference materials.** Germani, M.S.; Gokmen, I.; Sigleo, A.C.;. (Univ. of Maryland, College Park). Contract EY-76-S-05-5173. *Anal. Chem.;* **52**: No. 2, 240-245(Feb 1980).

Concentrations of 51 elements in the recently issued NBS bituminous Coal (SRM 1632a) and 43 elements in Subbituminous Coal (SRM 1635) have been measured mainly with the use of instrumental neutron activation analysis and neutron-capture prompt γ-ray activation analysis. The results are in good agreement with values reported for some of the elements in the standards by NBS. Concentration values for many elements in addition to those given by NBS are presented for comparison with results that may be obtained by other laboratories. 4 talbes.

30952 **Scientometric study of IAEA activation analysis conferences.** Lyon, W.S. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **33**: 231-232(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30953 **Instrumental analysis oc cow's milk and commercial infant formulae by neutron activation.** Vogt, J.R. (Univ. of Missouri, Columbia); Carni, J.; Morris, J.S.; Kay, M.A.; James, W.D.; Cunanan, S.A. *Trans. Am. Nucl. Soc.;* **33**: 232-233(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30954 **Mayan obsidian: source correlation for southern belize artifacts.** Stross, F.H.; Bowman, H.R.; Michel, H.V.; Asaro, F.; Hammond, N. (Lawrence Berkeley Lab., CA). *Archaeometry;* **20**: No. 1, 89-93(1978).

Forth-eight obsidian artifacts from sites in southern Belize (British Honduras) have been analyzed by high precision techniques of neutron activation analysis. The sensitivity and precision obtainable by neutron activation analysis made a study of source homogeneity attractive, and the two sources of obsidian that are thought to have been the major suppliers of the volcanic glass in pre-Columbian times, El Chayal and Ixtepeque, were studied in some detail. In this paper the results are summarized to provide a solid basis for comparison with the artifacts. The analytical results are summarized as: of the 23 samples from Wild Cane Cay, 19 are assignable to the Ixtepeque source, and four to El Chayal. The 3 samples from Moho and Frenchman's cays are assingable in Ixtepeque. Of the 22 samples from Lubaantun, 21 can be assigned to El Chayal, and one sample matches very closely in composition 2 obsidian blades from Ucareo, Michoacan (Mexico). For 20 elements, iron, manganese, cesium, uranium,cobalt, antimony, throium, rubidium, 1 hafnium, tantalum, the average difference in abundance for the 2 blades from Ucareo is only 3.4%, and the difference between these and the artifact from Lubaatun is only 3.3%. Thus, the 3 artifacts came from the same source although its location is unknown. From the observed chemical composition data, the obsidian from Wild Cane Cay derives both from Ixtepeque (≃82%) and from El Chayal (≃18%), which indicates the coastal and overland trade route networks linked up at this ideal natural harbor. Its nodal function in Mayan trade is confirmed by the quantities of exotic materials found on site. Presence of these materials implies trade contacts from northern Yucatan to the Pacific coast of Guatamela. 3 figures. (DP)

CHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 30966

30955 **Separation of technetium hydroxyethylidene diphosphonate complexes by anion-exchange high performance liquid chromatography.** Pinkerton, T.C.; Heineman, W.R.; Deutsch, E. (Univ. of Cincinnati, OH). *Anal. Chem.;* **52**: No. 7, 1106-1110(Jun 1980).

An anion-exchange high performance liquid chromatographic separation of technetium hydroxyethylidene diphosphonate (Tc-HEDP) complexes has been developed. Samples were prepared by the reduction of TcO_4^- in the presence of HEDP with $NaBH_4$. Samples contained millimolar concentrations of ^{99}Tc carrier and nanomolar concentrations of the γ-emitting /sup 99m/Tc isotope. Three modes of detection were used: (1) single wavelength at 405 nm, (2) uv-visible rapid scanning from 250 to 600 nm, and (3) single channel radiometric scintillation. The chromatograms illustrate that these radiopharmaceutical analogues consist of mixtures of at least seven Tc-containing species of unknown oxidation state, central metal configuration, and coordination environment. The distribution of components in these mixtures is dependent on reaction time and the presence of molecular oxygen. 9 figures, 1 table.

30956 **High precision isotopic ratio analysis of volatile metal chelates.** Hachey, D.L.; Blais, J.C.; Klein, P.D. (Argonne National Lab., IL). Contract W-31-109-ENG-38. *Anal. Chem.;* **52**: No. 7, 1131-1135(Jun 1980).

High precision isotope ratio measurements have been made for a series of volatile alkaline earth and transition metal chelates using conventional GC/MS instrumentation. Electron ionization was used for alkaline earth chelates, whereas isobutane chemical ionization was used for transition metal studies. Natural isotopic abundances were determined for a series of Mg, Ca, Cr, Fe, Ni, Cu, Cd, and Zn chelates. Absolute accuracy ranged between 0.01 and 1.19 at.

%. Absolute precision ranged between +-0.01-0.27 at. % (RSD +-0.07-10.26%) for elements that contained as many as eight natural isotopes. Calibration curves were prepared using natural abundance metals and their enriched ^{50}Cr, ^{60}Ni, and ^{65}Cu isotopes covering the range 0.1-1010.7 at. % excess. A separate multiple isotope calibration curve was similarly prepared using enriched ^{60}Ni (0.02-2.15 at. % excess) and ^{62}Ni (0.23-18.5 at. % excess). The samples were analyzed by GC/CI/MS. Human plasma, containing enriched ^{26}Mg and ^{44}Ca, was analyzed by EI/MS. 1 figure, 5 tables.

30957 Silicone coated oscillator for density meter analysis of caustic samples. Rivera, J.T. (Rockwell Hanford Operations, Richland, WA). Contract DE-AC06-77RL01030. *Anal. Chem.;* **52**: No. 7, 1161-1162(Jun 1980).

Recent samples submitted for density measurement have been generally high in hydroxide concentration, on the order of 8 M NaOH. A Mettler DMA 45 Calculating Density Meter has been used for the density determination of more than 1200 individual samples. However, the high concentration of hydroxide resulted in frequent recalibration of the instrument. A siliconizing fluid with the trade name of Surfasil was described as forming a film to glass which is unaffected by organic solvents and not easily hydrolyzed by either acids or bases. This liquid was tested as a possible aid in minimmizing the frequency of recalibration. The results showed much improved precision following treatment with Surfasil. 1 table. (DP)

30958 Fluorosilicate equilibria in sodium chloride solutions from 0 to 60°C. Busey, R.H. (Oak Ridge National Lab., TN); Schwartz, E.; Mesmer, R.E. Contract W-7405-ENG-26. *Inorg. Chem.;* **19**: No. 3, 758-761(Mar 1980).

A potentiometric method employing quinhydrone and solid-state fluoride electrodes was used to observe the free hydrogen ion and the free fluoride ion concentrations in equilibrium experiments in aqueous solutions at 0 to 60°C. In dilute silicic acid solutions the predominant reaction can be expressed as $Si(OH)_4(aq) + 4H^+ + 6F^-$ reversible $SiF_6^{2-} + 4H_2O$. The logarithm of the equilibrium quotient has values of 31.610, 29.980, and 28.23 at 0, 25, and 60°C in 1 m NaCl (molal units). There is evidence for the existence of small amounts of additional species with fewer fluorides under certain conditions. The absence of a regular sequence of species from the array Si(OH)/sub 4-x/ F/sub y//sup x-y/ is proven by an analysis of the results. The average number of fluoride ions complexed by millimolal silicic acid approaches 6.0 in 0.01 m fluoride as the pH is reduced to 3 or lower in titration experiments. Simultaneously the average number of hydrogen ions consumed approaches 4.0. 2 tables, 4 figures.

30959 Capillary gas chromatography/mass spectrometric determination of nitrogen aromatic compounds in complex mixtures. Novotny, M.; Kump, R.; Merli, F.; Todd, L.J. (Indiana Univ., Bloomington). Contract EY-76-S-02-2856. *Anal. Chem.;* **52**: No. 3, 401-406(Mar 1980).

Capillary GC separation of nitrogen-containing aromatics has been accomplished with deactivated glass columns. High-precision retention measurements of pyridine and quinoline derivatives are reported, utilizing parent aza-arenes as retention standards. As shown on the example of GC/MS analysis of aromatic bases extracted from the recycle oil of solvent-refined coal, both precisely measured retention data and mass spectral information combined can lead to positive identification. 2 figures, 3 tables.

30960 Thermally stable dexsil-400 glass capillary columns. Maskarinec, M.P.; Olerich, G. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Anal. Chem.;* **52**: No. 3, 588-591(Mar 1980).

The factors affecting efficiency, thermal stability, and reproducibility of Dexsil-400 glass capillary columns for gas chromatography in general, and for polycyclic aromatic hydrocarbons (PAHs) in particular were investigated. Columns were drawn from Kimble KG-6 (soda-lime) glass or Kimox (borosilicate) glass. All silylation was carried out at 200°C. Columns were coated according to the static method. Freshly prepared, degassed solutions of Dexsil-400 in pentane or methylene chloride were used. Thermal stability of the Dexsil 400 columns with respect to gas chromatography/mass spectrometry (GC/MS) were tested. Column-to-column variability is a function of each step in the fabrication of the columns. The degree of etching, extent of silylation, and stationary phase film thickness must be carefully controlled. The variability in two Dexsil-400 capillary column prepared by etching, silylation with solution of hexa methyl disilazone (HMDS), and static coating is shown and also indicates the excellent selectivity of Dexsil-400 for the separation of alkylated aromatic compounds. The wide temperature range of Dexsil-400 and the high efficiency of the capillary columns also allow the analysis of complex mixtures with minimal prefractionation. Direct injection of a coal liquefaction product is given. Analysis by GC/MS indicated the presence of parent PAHs, alkylated PAHs, nitrogen and sulfur heterocycles, and their alkylated derivatives. 4 figures. (DP)

RADIOMETRIC AND RADIOCHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 30235, 30264, 30331, 30332, 30333, 30955

30961 (BDX—613-2411) X-ray fluorescence analysis of metal concentration in an alloy electroplating bath. Hines, R.A. (Bendix Corp., Kansas City, MO (USA)). Jun 1980. Contract AC04-76DP00613. 38p. NTIS, PC A03/MF A01.

An energy-dispersive x-ray fluorescence analysis system has been developed for rapid, simultaneous analysis of gold and copper concentrations in an aqueous electroplating bath. The speed and repeatability of the system make it well suited for in-process control. Data collection and reduction are automatic. The analysis requires less than 10 minutes from taking the sample to printing the gold and copper concentrations.

30962 (BNL—27914) Proton microprobe analysis of zinc in skeletal tissues. Doty, S.B.; Jones, K.W.; Kraner, H.W.; Shroy, R.E.; Hanson, A.L. (Columbia Univ., New York (USA); Brookhaven National Lab., Upton, NY (USA)). Jun 1980. Contract AC02-76CH00016. 17p. (CONF-800677—1). NTIS, PC A02/MF A01.

From 2. international conference on particle induced X-ray emission and its analytical applications; Lund, Sweden (8 Jun 1980).

A proton microprobe with windowless exit port was used to study zinc distributions in various types of skeletal tissues. The use of an external beam facilitated positioning of the targets for examination of particular points of interest. The proton microprobe is uniquely suited to this work since it combines high sensitivity for zinc determinations in thick samples with good spatial resolution. Measurements on rat and rabbit Achilles tendon showed a significant increase in zinc concentrations as the beam moved from the unmineralized collagen into the mineralized attachment site. Cartilage gave a similar result, with calcified cartilage having a greater zinc level than the articular surface on unmineralized epiphyseal cartilage.

30963 (LA—8372-MS) ^{242}Pu isotopic verification. Sampson, T.E.; Johnson, S.; Kroncke, K. (Los Alamos Scientific Lab., NM (USA)). May 1980. Contract W-7405-ENG-36. 19p. NTIS, PC A02/MF A01.

This document reports on measurement methods being developed and implemented to verify nondestructively the isotopic composition of certain batches of plutonium highly enriched in ^{242}Pu. High-resolution gamma-ray spectroscopy techniques are used to measure the isotopic ratios of $^{239}Pu/^{241}Pu$ and $^{239}Pu/^{241}Pu$, which are minor constituents of the enriched ^{242}Pu. These ratios uniquely verify the specific batch of ^{242}Pu and can indicate with high sensitivity if the ^{242}Pu has been contaminated with plutonium of the other isotopic compositions. Data are presented that illustrate the successful application of these techniques to samples of arbitrary geometry ranging in mass from ~ 0.1 g to > 2 kg.

30964 Uranium and thorium correlated with particle size in phosphate fertilizers. Metzger, R. (Arizona State Univ., Tempe); McKlveen, J.W.; Jenkins, R.; McDowell, W.J. *Trans. Am. Nucl. Soc.;* **33**: 230-231(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

30965 Coincident sum peaks as a tool in low-energy gamma spectrometry. Sill, A.F. (Rockwell Hanford Operations, Richland, WA). *Trans. Am. Nucl. Soc.;* **33**: 235-236(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

SPECTRAL PROCEDURES

REFER ALSO TO CITATION(S) 30218, 30235, 30244, 30398, 30400, 30956, 30959, 30992

30966 (ANL—80-41) Methods of chemical analysis used to characterize battery materials. Jensen, K.J.; Streets, W.E. (Argonne National Lab., IL (USA)). May 1980. Contract W-31-109-ENG-38. 51p. NTIS, PC A04/MF A01.

Procedures are given for the chemical analysis of a variety of materials of interest in battery development and research. These materials include LiCl-KCl eutectic, Li-Al alloys, lithium sulfide, lithium aluminum chloride, calcium sulfide, titanium sulfide, and various sulfides of iron, nickel, copper, and cobalt. 8 tables.

30967 (SAND—80-0605) Chemical analysis of thin films at Sandia National Laboratories. Tallant, D.R.; Taylor, E.L. (Sandia National Labs., Albuquerque, NM (USA)). May 1980. Contract AC04-76DP00789. 45p. NTIS, PC A03/MF A01.

The characterization of thin films produced by chemical and physical vapor deposition requires special analytical techniques. When the average compositions of the films are required, dissolution of the thin films and measurement of the concentrations of the solubilized species is the appropriate analytical approach. In this

report techniques for the wet chemical analysis of thin films of Si:Al, P_2O_5:SiO_2, B_2O_3:SiO_2, TiB/sub x/ and TaB/sub x/ are described. The analyses are complicated by the small total quantities of these analytes present in the films, the refractory characters of these analytes, and the possibility of interferences from the substrates on which the films are deposited. Etching conditions are described which dissolve the thin films without introducing interferences from the substrates. A chemical amplification technique and inductively coupled plasma atomic emission spectrometry are shown to provide the sensitivity required to measure the small total quantities (micrograms to milligrams) of analytes present. Also the chemical analysis data has been used to calibrate normal infrared absorption spectroscopy to give fast estimates of the phosphorus and/or boron dopant levels in thin SiO_2 films.

30968 Nitric oxide determination by a Zeeman-tuned frequency-modulated atomic line source. Koizumi, H.; Hadeishi, T.; McLaughlin, R.D. (Univ. of California, Berkeley). Contract W-7405-ENG-48. *Anal. Chem.;* **52**: No. 3, 500-504(Mar 1980).

Magnetically tuned emission lines from ions and atoms were utilized to determine concentrations of NO gas with high selectivity and high sensitivity. One of the Zeeman components of an emission line was shifted to exactly coincide with a single rotational-vibrational line of NO, whereas the other component was shifted away from the NO line. The coincident component indicated the extent of NO absorption and the noncoincident component measured the extent of background absorption. By making use of a differential measurement, light scattering and molecular absorption caused by coexisting small particles and gases were cancelled out. Detection limits of NO in N_2 were about 30 ppb and 150 ppb at low pressure and at atmospheric pressure, respectively. 11 figures, 2 tables.

30969 Portable centrifugal analyzer for the determination of rapid reaction kinetics. Bostick, W.D.; Bauer, M.L.; McCracken, R.; Mrochek, J.E. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Anal. Chem.;* **52**: No. 2, 300-306(Feb 1980).

A portable centrifugal analyzer prototype is capable of rapidly initiating reactions and monitoring 17 optical channels as they rotate past a stationary photodetector. An advanced rotor drive permits transfer of discretely loaded sample and reagent into a cuvette within 60 ms. Various rotor designs have been employed to ensure effieicnt mixing concurrent with solution transfer, thus permitting absorbance or luminescence measurements to be made almost immediately after solution contract. Dye-dillution studies have been used to investigate transfer and mixing efficiencies. Rotor designs with parallel access for sample and reagent into the cuvette were found to promote efficient mixing during liquid transfer. The hypochlorite-luminol chemiluminescent reaction served to demonstrate the utility of the system for performing rapid kinetic analyses. Appropriate adjustment of reaction conditions allows first-order reaction half-lives as short as 0.04 s to be measured. 13 figures, 3 tables.

30970 High pressure chemical ionization source with coaxial electron entrance and ion extraction apertures. Illies, A.J.; Meisels, G.G. (Univ. of Nebraska, Lincoln). Contract EY-76-S-02-2567. *Anal. Chem.;* **52**: No. 2, 325-329(Feb 1980).

A high pressure chemical ionization source operable up to 3 Torr which has good analytical chemical ionization sensitivity (1 x 10/sup -10/ C/μg for methyl sterate) is described. The source has coaxial geometry between electron entrance aperture and ion exit slit, two field shaping rings which lead to parallel equipotential lines over an area of ca. 25 mm^2 throughout the entire drift region, temperature equillbration of the reactant gas prior to its entry into the reaction by passing it through thermallzing channels in the source block itself, and provisions for cooling and heating to make a temperature range of 175 to 500 K accessible. This source displays characteristics of a drift tube allowing the determination of ion transport properties. Reduced mobilities for He+, Ne+, Ar+, N_2+, and N_4+ in their parent gases are within 10% of the accepted literature values. 8 figures, 2 tables.

30971 Dual beam fiber optic time-of-flight spectrometer. Whitten, W.B.; Ross, H.H. (Oak Ridge National Lab., TN). *Anal. Chem.;* **52**: No. 1, 101-104(Jan 1980).

A dual beam spectrometer has been constructed which uses the variation in light velocity with wavelength in an optical fiber to provide spectral dispersion in the time domain. Two fibers of different lengths constitute the sample and reference channels which are time-delay multiplexed and monitored by a single photomultiplier. Time-correlated single photon counting techniques provide the neessary timing accuracy for satisfactory spectral resolution. 5 figures, 1 table.

30972 Spark source mass spectrometry in archaeological chemistry. Friedman, A.M.; Lerner, J. (Argonne National Lab., IL). *Adv. Chem. Ser.;* No. 171, 70-78(1977).

Techniques for analysis and sample preparation have been developed for using spark source mass spectrometry (SSMS) to study archaeological samples. Comparative studies of neutron activation and SSMS on identical samples have been made. The technique is used to determine the ores of origin of two series of early Peruvian artifacts. 4 tables, 5 figures.

SEPARATION PROCEDURES

REFER ALSO TO CITATION(S) 30055, 30056, 30284, 31182

INORGANIC AND PHYSICAL CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 30125, 30182, 30183, 30184, 30354, 30928, 30958, 30969, 30970, 30997, 31005, 31129

30973 (BNL—28041) Two approaches to 3D reconstruction in NMR zeugmatography. Marr, R.B.; Chen, C.N.; Lauterbur, P.C. (Brookhaven National Lab., Upton, NY (USA); State Univ. of New York, Stony Brook (USA)). 1980. Contract AC02-76CH00016. 17p. (CONF-800247—1). NTIS, PC A02/MF A01.

From Conference on mathematical aspects of computerized tomography; Oberwolfach, F.R. Germany (10 Feb 1980).

In nuclear magnetic resonance (NMR) zeugmatography, the primary data pertain to integrals of the unknown nuclear spin density f(x,y,z) over planes instead of lines in R^3. Two natural approaches to reconstructing f from such data are: (1) By numerical implementation of the inverse Radon transform in three dimensions (the direct approach), and (2) by application, in two successive stages, of existing well-known algorithms for inverting the two-dimensional Radon transform (the two-stage approach). These two approaches are discussed and compared, both from a theoretical standpoint and through computer results obtained with real NMR data. For the cases studied to date the two methods appear to produce qualitatively similar results.

30974 (DOE/ER—0058) Summaries of FY 1979 research in the chemical sciences. (Department of Energy, Washington, DC (USA). Office of Energy Research). May 1980. 285p. NTIS, PC A13/MF A01.

The purpose of this report is to help those interested in research supported by the Department of Energy's Division of Chemical Sciences, which is one of six Divisions of the Office of Basic Energy Sciences in the Office of Energy Research. Chemists, physicists, chemical engineers and others who are considering the possibility of proposing research for support by this Division wll find the booklet useful for gauging the scope of the program in basic research, and the relationship of their interests to the overall program. These smmaries are intended to provide a rapid means for becoming acquainted with the Chemical Sciences program for members of the scientific and technological public, and interested persons in the Legislative and Executive Branches of the Government, in order to indicate the areas of research supported by the Division and energy technologies which may be advanced by use of basic knowledge discovered in this program. Scientific excellence is a major criterion applied in the selection of research supported by Chemical Sciences. Another important consideration is the identifying of chemical, physical and chemical engineering subdisciplines which are advancing in ways which produce new information related to energy, needed data, or new ideas.

30975 (DOE/ER/01198—1317) Silver diffusion and isotope effect in silver rubidium iodide. Arzigian, J.S. (Illinois Univ., Urbana (USA). Dept. of Physics). 1980. Contract AC02-76ER01198. 93p. NTIS, PC A05/MF A01.

Thesis.

The diffusion coefficient of silver in $RbAg_4I_5$ was measured in both superionic phases using radiotracer Ag-110m and serial sectioning with a low temperature sectioning apparatus. The activation energies for diffusion in alpha-$RbAg_4I_5$ and beta-$RbAg_4I_5$, respectively, are 0.11 +- 0.01 eV and 0.20 +- 0.04 eV. An isotope effect for diffusion was also measured in both superionic phases. Ag-105 and Ag-110m radioisotopes were used with gamma spectroscopy and cnergy discrimination. The effect is small, with no significant temperature variation, with the value at 333°K being 0.12 +- 0.01. The second-order phase transition at 208°K has a small effect, if any, on the magnitude of the effect. The data suggest that a highly cooperative transport mechanism is responsible for the unusually high values of both the conductivity and diffusion coefficient. Although it is not possible to deduce the particular mechanism involved, theories inolving ionic polarons, or cooperative motion, such as crowdions or solitons, seem consistent with the observed results.

30976 (FE—2408-10) Study of the mechanism of the hydrogen sulfide/dolomite reaction. Quarterly report, October-December 1978. Li, K.; Rogan, F.H.; Yen, J.H.; Huang, C.S. (Carnegie-Mellon Univ.,

Pittsburgh, PA (USA). Dept. of Chemical Engineering). Mar 1979. Contract EX-76-C-01-2408. 84p. NTIS, PC A05/MF A01.

Direct structural evidence was obtained this quarter to demonstrate that, at temperatures above 820°C, the half-calcination reaction is of the pearlite type. Rate data indicate a gradual transition to a different mechanism as the temperature is lowered from 820°C to 710°C. The rate data fit the Avrami equation with n = 2 for temperatures above 820°C, or with n = 3/4 for temperatures below 710°C; for intermediate temperatures the data cannot be fitted using a single value of n. A basic model for sulfidation was completed, capable of successfully predicting experimentally observed weight changes for a wide range of operating conditions. The model contains no adjustable parameters. The ability of water or hydrogen to promote, or of CO_2 to retard sulfidation, observed experimentally, has yet to be incorporated into the model. Gas phase reactions among inlet species play a role in the CO_2 effect, while the effect of water or hydrogen is believed to be catalytic. The carbonation reaction was observed by SEM to occur essentially topochemically at high temperatures (above 700°C). Test fits of the high temperature rate data to a shrinking core model assuming mass transfer control showed good agreement. At lower temperatures, however, the reaction appears non-topochemical.

30977 **Coordination chemist's view of surface science.** Muetterties, E.L. (Cornell Univ., Ithaca, NY). *Angew. Chem. Int. Ed. Engl.;* **17**: No. 8, 545-588(Aug 1978).

Structure, a necessary element for an understanding of chemistry, has not been precisely defined, in molecular detail, for the surface species formed at a solid-gas interface. Dramatic advances in theory, instruments and experimental procedures have now provided the surface scientists with an impressive arsenal of structural and electronic probes. Chemistry in the form of the classic reaction can also provide an insight to the structure of surface compounds. In fact, many of the experimental procedures and systematics of the coordination and organometallic chemist can be effectively utilized in a complementary fashion with surface physics techniques to gain a more definitive picture of chemisorption states and or reactions at a surface.

30978 (LBL—9839) **Theoretical aspects of solid state reactions in a mixed particulate ensemble and kinetics of lead zirconate formation.** Chandratreya, S.S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1979. Contract W-7405-ENG-48. 151p. NTIS, PC A08/MF A01.

Thesis.

A theoretical analysis was carried out to estimate the quasi-steady-state external mass transport by lattice, surface and gaseous diffusion in terms of the stereologically measurable microstructural parameters of a mixed powder compact. It was shown that the gaseous transport can be described by a single dimensionless quantity termed sublimation transport modulus. Using these equations, the relative importance of the alternate external transport modes can be evaluated. Experimental work determined the reaction isotherms for the formation of lead zirconate from yellow PbO and monoclinic zirconia between 710°C to 810°C for two zirconia size distributions. The larger zirconia showed diffusion controlled shrinking core kinetics up to about 90 percent reaction while the smaller zirconia indicated a diffusion controlled spherical growth of up to 85 percent reaction after an instantaneous nucleation at a limited number of sites. The difference was attributed to the differences in the mixing time and not to the particulate sizes. It was observed that for the same size range, a longer mixing operation gave a better dispersion of reactants which resulted in a higher nucleation site density required for a shrinking core type of product morphology and faster kinetics. A microprobe profile analysis of partially reacted particles confirmed that for the shorter mixing period, reaction resultedin a nucleation-growth-impingement type of morphology. The activation energy as calculated from the nucleation-growth model fit to the data was 138 Kcal/mole which is close to 131 Kcal/mole reported for Pb^{2+} diffusion in $PbZrO_3$. Approximate calculations show that the gaseous external mass flux of PbO was negligible compared to the lattice or surface diffusive flux.

30979 (LBL—10384) **Strain induced phenomena in $Ca(OH)_2$ made by reaction of CaO with water vapor.** Beruto, D.; Searcy, A.W.; Barco, L.; Belleri, G. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.; California Univ., Berkeley (USA). Dept. of Materials Science and Mineral Engineering; Genoa Univ. (Italy)). Jan 1980. Contract W-7405-ENG-48. 6p. (CONF-800902—2). NTIS, PC A02/MF A01.

From 9. international symposium on the reactivity of solids; Cracow, Poland (1 Sep 1980).

Three physically distinguishable, poorly crystalline forms of $Ca(OH)_2$ which are made by reactions of water vapor at 25°C with CaO powders evolve heat and develop sharper x-ray diffraction patterns when heated to 300°C. Measurements of x-ray diffraction peak line breadths, surface areas, porosities, and pore size distributions were made before and after heat treatment. The exothermic process of the one of these forms of $Ca(OH)_2$ which is nonporous is recrystallization of the highly strained solid to essentially unstrained crystals. The exothermic process in two porous forms of $Ca(OH)_2$, not only reduces their internal strains, but also reduces their surface areas and porosities.

30980 (SAND—80-8637) **J dependence of nitrogen Q branch linewidths.** Rahn, L.A.; Owyoung, A.; Coltrin, M.E.; Koszykowski, M.L. (Sandia Labs., Livermore, CA (USA)). Jun 1980. Contract AC04-76DP00789. 15p. (CONF-800808—5). NTIS, PC A02/MF A01.

From 7. international conference on raman spectroscopy; Ottawa, Canada (4 Aug 1980).

High resolution inverse Raman spectroscopy has been used to determine for the first time the dependence of molecular nitrogen Q branch linewidths on the rotational quantum number (J) at room temperature and at high temperatures. Preliminary quasi-classical calculations are presented which are in excellent agreement with the low temperature experimental results.

30981 (UCRL—84562) **High temperature enthalpies of zinc sulfate and zinc oxy-sulfate.** Hosmer, P.K.; Krikorian, O.H. (California Univ., Livermore (USA). Lawrence Livermore National Lab.). 23 Jun 1980. Contract W-7405-ENG-48. 37p. (CONF-800670—2). NTIS, PC A03/MF A01.

From 7. European thermophysical properties conference; Antwerpen, Belgium (30 Jun 1980).

The high temperature enthalpies (500 to 1200 K) of zinc sulfate and zinc oxy-sulfate were measured using a drop calorimeter. The data include determination of the transformation enthalpy associated with the alpha to beta phase transition of zinc sulfate which occurs at approximately 1015 K. This information extends the range of thermodynamic information for zinc sulfate into the temperature regime where zinc sulfate decomposition becomes significant and has useful applications in thermochemical cycles for the production of hydrogen.

30982 **Synthesis and physical properties of hexakis(isothiocyanato)technetate(III) and -(IV) complexes. Structure of the $[Tc(NCS)_6]^{3-}$ ion.** Trop, H.S. (Massachusetts Inst. of Tech., Cambridge); Davison, A.; Jones, A.G.; Davis, M.A.; Szalda, D.J.; Lippard, S.J. Contract E(11-1)4115. *Inorg. Chem.;* **19**: No. 5, 1105-1110(May 1980).

The reaction between ammonium thiocyanate and $(NH_4)_2TcX_6$, X = Cl and Br, salts is shown to produce a mixture of red (λ 500 nm) $[Tc(NCS)_6]^{2-}$ and air-sensitive yellow (λ 400 nm) $[Tc(NCS)_6]^{2-}$ ions. These species were chromatographically separated and isolated as their ammonium, tetraphenylarsonium, or tetra-n-butylammonium salts. The technetium(IV) compound was also obtained through reduction of ammonium pertechnetate followed by treatment with ceric ion. Infrared, Raman, conductivity, and magnetic susceptibility data are reported for these complexes and shown to be consistent with octahedral structures. The detailed geometry of $(n\text{-}Bu_4N)_2[Tc(NCS)_6]$ was determined in a single-crystal X-ray diffractionn study. The compound crystallizes in the cubic system, space group Pa3, with a = 24.444 (6) A and Z = 8. The technetium atom is situated on a crystallographic threefold rotation axis. The Tc-N bond lengths are 2.04 (2) and 2.05 (2) A, and the N-Tc-N angles range from 88.0 (6) to 92.1 (7)°, indicative of nearly perfect octahedral symmetry. The average Tc-N-C and N-C-S bond angles are 173 (2) and 177 (2)°, respectively. Voltammetric studies in acetonitrile show a reversible one-electron transfer between $[Tc(NCS)_6]^{2-}$ and $[Tc(NCS)_6]^{3-}$ with E/sub 1/2/ of 0.18 V vs. SCE. Additional chemical redox reactions of these ions are reported.

30983 **Cis-trans isomerism in $(trpy)(PPh_3)RuCl_2$. Comparisons between the chemical and physical properties of a cis-trans isomeric pair.** Sullivan, B.P.; Calvert, J.M.; Meyer, T.J. (Univ. of North Carolina, Chapel Hill). Contract ER-78-S-05-6034. *Inorg. Chem.;* **19**: No. 5, 1404-1407(May 1980).

The syntheses of complexes derived from the planar, tridentate ligand 2,2',2"-terpyridine (trpy) of the type (trpy)Ru/sup II/ $(L)Cl_2$ where L = PPh_3, $P(p\text{-}C_6H_4Me)_3$, or pyridine are described. Some rather striking differences in the properties of the cis anc trans-isomers of the phosphine derivatives are reported. (BLM).

30984 **Pore closure models for gas-solid reactions. The effect of bulk flow and reversibility.** Ulrichson, D.L.; Mahoney, D.J. (Iowa State Univ., Ames). Contract W-7405-ENG-82. *Chem. Eng. Sci.;* **35**: No. 3, 567-575(1980).

A pore closure model of gas-solid reactions has been extended to include the effect of bulk flow and reversible reactions. Both effects are shown to be of major importance in the chlorination of magnesia. During the course of reaction the controlling resistance is shown to change from pore diffusion to product layer diffusion to pore diffusion caused by closure of the pore.

30985 **On shape normalization fo non-uniformly active catalyst pellets.** Wang, J.B.; Varma, A. (Univ. of Notre Dame, IN). *Chem. Eng. Sci.;* **35**: No. 3, 613-617(1980).

The possibility of shape normalization of catalyst pellets with non-uniform catalytic activity profiles is examined. A first order isothermal reaction occurring in slab or spherical catalyst pellets, with a variety of activity profiles, is considered. Analytic solutions for the effectiveness factor are reported in all cases. When the catalytic activity at the external surface of the pellet is non-zero, a physically significant normalization of the Thiele modulus is suggested which makes the asymptotic behavior of the effectiveness factor identical for all pellet shapes and all activity profiles. For an operational range intermediate between kinetic and diffusion control, however, the normalization can lead to significant errors. No such normalization exists when the surface catalytic activity is zero.

30986 Heat capacity of rare earth sesquisulfides. Ho, J.C. (Wichita State Univ., KA); Taher, S.M.A.; King, G.B.; Gruber, J.B.; Beaudry, B.J.; Gschneidner, K.A. Jr. *J. Phys. (Paris), Colloq.;* **8**: No. 59, C6.840-C6.842(1978).

Heat capacity measurements between about 2 and 20 K have been made on a series of nearly stoichiometric rare earth sesquisulfides $RS_{1.5}$ with R = La, Ce, Pr, Nd, Gd, Tb, Dy, Ho, Er, Tm or Lu. No magnetic ordering was observed. Extra heat capacity contributions beyond those due to the lattice and conduction electrons occur in all cases except in the La and Lu compounds. Such contributions are mostly of the Schottky type associated with crystal field effects. 2 figures.

30987 Cesium hydrogen tartrate and anomalous dispersion of cesium. Templeton, L.K.; Templeton, D.H. (Lawrence Berkeley Lab., CA). *Acta Crystallogr., Sect. A;* **34**: 368-371(1978).

Cesium hydrogen (+)-tartrate is orthorhombic, $P2_12_12_1$, a = 8.076 (3), b = 11.621 (5), c = 7.692 (3) A, Z = 4, D/sub x/ = 2.594 g cm^{-3}, at 22°C. Its structure, nearly the same as that of ammonium hydrogen tartrate, was refined to R = 0.016 for 2442 reflections ($F^2 > 3\sigma$) out to d = 0.66 A. Our least-squares program was modified to treat anomalous-dispersion terms as independent adjustable parameters, and f" for cesium was determined as 2.22 (6) e for Mo Kα radiation. In the determination of absolute configuration or polarity, refinement of f" for a heavy atom has the advantage that one can detect inversion twinning, as well as save on computational time. 4 tables, 2 figures.

30988 Temperature independence of the angle-resolved x-ray photoemission spectra of gold and platinum valence bands. Dabbousi, O.B.; Wehner, P.S.; Shirley, D.A. (Univ. of California, Berkeley). *Solid State Commun.;* **28**: 227-231(1978).

Angle-resolved valence-band x-ray photoemission spectra were taken along the [111] and [100] directions of gold single crystals and along the [100] direction of a platinum single crystal at room temperature (293K) and on a probe cooled nearly to liquid nitrogen temperature (77K). No change was detected on cooling the samples, in contrast to expectations based on a simple direct-transition model. A simple matrix-element model appears to predict spectra well even at low temperatures, perhaps because the complexity of the high-energy final-state bands permits sampling effectively throughout the zone.

30989 Crystal and molecular structure of $Cs_3Sb_2I_9$. Ho, D.; Riley, W.C.; Jacobson, R.A. (Ames Lab., IO). *Cryst. Struct. Commun.;* **7**: 111-114(1978).

Crystalline $Cs_3Sb_2I_9$ was prepared by dissolving stoichiometric amounts of CsI and SbI_3 in 20% HI and then recrystallizing from 20% HI. The unit cell of $Cs_3Sb_2I_9$ was found to contain two $Sb_2I_9^{3-}$ anions and six cesium cations. Selected crystal data are reported for the compound. (BLM)

30990 One-magnon luminescence sidebands of the excitonic transition in MnF_2. Chiang, T.C.; Salvi, P.R.; Davies, J.; Shen, Y.R. (Lawrence Berkely Lab., CA). *Solid State Commun.;* **26**: 217-220(1978).

We report the first observation of the π-polarized one-magnon excitonic luminescence sideband in MnF_2. The theory of Loudon is used to fit the experimental spectrum quantitatively. An effective temperature of the crystal is deduced from the simultaneously observed antiStokes sideband emission. 3 figures.

ISOTOPE EFFECTS

REFER ALSO TO CITATION(S) 30348

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

REFER ALSO TO CITATION(S) 30342

30991 Gas chromatographic fractionations of the carbon and oxygen isotopes of carbon monoxide. Fetzer, J.C.; Bloxham, P.A.; Rogers, L.B. (Univ. of Georgia, Athens). *Sep. Sci. Technol.;* **15**: No. 1, 49-56(1980).

A high-precision gas chromatograph was used in conjunction with a quadrupole mass spectrometer and an on-line computer to study the fractionation of carbon and oxygen isotopes in carbon monoxide on silica and on finely divided nickel powder. Relative retentions were studied as a function of temperature using both natural abundances and isotopically enriched species. On silica, the values ranged from 0.99639 +- 0.00046 to 1.00152 +- 0.00089 for the $^{13}C/^{12}C$ pair and from 1.00054 +- 0.00057 to 1.00162 +- 0.00039 for the $^{16}O/^{18}O$ pair. The values on nickel were greater, average values being 1.037 for he $^{12}C/^{13}C$ pair and 1.009 for the $^{16}O/^{18}O$ pair. The larger values on nickel compared to those on silica reflect the much stronger interaction. 3 tables.

ORGANIC CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 30122, 30357, 30935, 30977, 30983, 31171, 31448

30992 Isolation and characterization of $[Rh_5(CO)_{10}(\mu_2\text{-}CO)_5]^-$: a key product in rhodium carbonyl chemistry. Fumagalli, A. (Brookhaven National Lab., Upton, NY); Koetzle, T.F.; Takusagawa, F.; Chini, P.; Martinengo, S.; Heaton, B.T. *J. Am. Chem. Soc.;* **102**: No. 5, 1740-1742(27 Feb 1980).

The species, $[Rh_{12}(CO)/sub\ \sim 34/]^{2-}$ has been reformulated as $[Rh_5(CO)_{15}J]$; and the pentanuclear cluster was obtained by starting from $Rh_4(CO)_{12}$ and the $[Rh(CO)_4J]^-$ anion. At low temperature (-78°C), reaction of $[Rh_{12}(CO)_{30}]^{2-}$ with carbon monoxide (laton P) in THF led to slow precipitation of $Rh_6(CO)_{16}$ in such a way that the resultant equilibrium shifted toward formation of the labile species. The x-ray structural analysis showed the anionic species to be $[Rh_5(CO)_{15}]^-$. The $[PPN]^+$ $[Rh_5(CO)_{15}]^-$ salt has been characterized by single-crystal x-ray diffraction techniques. The structure of the $[Rh_5(CO)_{15}]^-$ anion in the crystalline state is illustrated. The present structure is an example of a trigonal-bipyramidal cluster with 76 valence electrons. At -80°C in perdeuterioacetone, the 25- and 90-MHz ^{13}C NMR spectra of the $[Rh_5(CO)_{15}]^-$ anion are identical and are the same as that previously reported for $[Rh_{12}(CO)/sub\ \sim 34/]^{2-}$. It was observed that the slow decomposition of $[Rh_5(CO)_{15}]^-$ species in THF solution under nitrogen takes place. The equation appears to be a key reaction involved in the reported equilibrium between $[Rh_{12}(CO)/sub \sim 34/]^{2-}$ and $[Rh_{12}(CO)_{30}]^{2-}$.3 figures. (DP)

30993 New synthetic use of nucleoside N^1-oxides. MacCoss, M.; Ryu, E.K.; White, R.S.; Last, R.L. (Argonne National Lab., IL). Contract W-31-109-ENG-38. *J. Org. Chem.;* **45**: No. 5, 788-794(29 Feb 1980).

The use of adenosine N^1-oxide derivatives to prevent intramolecular cyclization during nucleophilic displacement reactions on the sugar moiety is described. This new synthetic use of N^1-oxides is illustrated by the synthesis of 5'-O-(p-toluenesulfonyl)-2',3'-O-isopropylideneadenosine N^1-oxide (6) and subsequent displacement of the 5' substituent with iodide or azide under conditions which lead exclusively to $N^3 \rightarrow 5'$ intramolecular cyclization in the absence of the N^1-oxide. Similarly, reaction of 2',3'-O-isopropylideneadenosine N^1-oxide with methyltriphenoxyphosphonium iodide produces 5'-iodo-5'-deoxy-2',3'-O-isopropylideneadenosine N^1-oxide (7) with no observable cyclization. In addition, 2',3'-anhydroadenosine N^1-oxide (17) is shown to be stable under conditions that lead to complete $N^3 \rightarrow 3'$ intramolecular cyclization in the upprotected 2',3'-anhydroadenosine (14). Reduction of the N^1-oxide to produce the parent nucleoside is readily achieved by using hexachlorodisilane or by hydrogenating over Raney nickel. The mechanistical rationale and implications for additional nucleoside transformations are discussed. 2 tables, 1 figure.

30994 Effect of pH on the behavior of duroquinone triplets. Scaiano, J.C.; Neta, P. (Univ. of Notre Dame, IN). *J. Am. Chem. Soc.;* **102**: No. 5, 1608-1611(27 Feb 1980).

The triplet state of duroquinone has a pK/sub a/ of -0.1. The protonated form interacts with benzyl alcohol and chloride ions with rate constants which are about two orders of magnitude faster than those of the neutral form. Duroquinone triplets are quenched by a variety of inorganic anions, including OH-, for which the rate constant is 1.5 x 10^9 $M^{-1}s^{-1}$. Quenching by amines and its pH dependence have also been examined. 4 figures, 1 table.

30995 Studies on free and enzyme-bound nicotinamide adenine dinucleotide free radicals. Bielski, B.H.J. (Brookhaven National Lab., Upton, NY); Chan, P.C. *J. Am. Chem. Soc.;* **102**: No. 5, 1713-1716(27 Feb 1980).

The spectral and kinetic properties of the NAD free radical have been studied as a function of temperature and pH. The radical decays by second-order kinetics to an enzymatically inactive dimer $(NAD)_2$. At 23.5°C and pH 7.3 the corresponding rate constant is k_9 = (7.72 +- 0.78) x 10^7 $M^{-1}s^{-1}$ with an activation energy E/sub a/ = 3.4 +- 0.4 kcal/mol. Upon attachment of the NAD radical to an

enzyme active site, the radical becomes stabilized. The stabilization effect (ratio of the rate of NAD disappearance in the absence and presence of an enzyme) depends upon the nature of the enzyme and varies from 1.54 x 10^3 for alcohol dehydrogenase, 2.57 x 10^3 for malate dehydrogenase, 1.1 x 10^3 for lactate dehydrogenase, to 1.54 x 10^4 for glyceraldehyde-3-phosphate dehydrogenase. The observed second-order disappearance of enzyme-stabilized NAD is explained by a mechanism that is dependent upon the dissociation constant of the enzyme-NAD complex. 6 figures

30996 Coordination chemistry of metal surfaces: carbon monoxide chemisorption states on Pt(111). Friend, C.M.; Gavin, R.M.; Muetterties, E.L.; Tsai, M.C. (Univ. of California, Berkeley). Contract W-7405-ENG-48. *J. Am. Chem. Soc.;* **102**: No. 5, 1717-1719(27 Feb 1980).

A common observation in spectroscopic, diffraction, and thermal desorption studies is the apparent presence of two or more chemisorbed states considering CO on the Pt(III) surface, the major desorption peak has been ascribed uniformly to a CO chemisorption state on a Pt(III) surface and the minor peak has been variously associated with desorptions from other parts of the ultrahigh vacuum system to the edge areas of the crystal or to the ubiquitous imperfections of a real Pt(III) surface. Thermal desorption and chemical displacement reactions play a major role in establishing the surface coordination chemistry. The blank was prepared from a conventional platinum crystal wafer by vapor deposition of a thin copper layer followed by a thin gold layer. The blank studies demonstrated the observed thermal desorption of CO from the Pt(III) surface is totally associated with the real exposed crystal surfaces. The most common imperfections on a carefully prepared and annealed Pt(III) surface will be steps and kinks. In the interpretation of the vibrational data for CO on Pt(III), consideration should be given to the possibility that the energy loss at 2080 cm^{-1} arises from CO chemisorbed at imperfections on a real Pt(III) crystal face and that CO chemisorbed on the Pt(III) plane has a CO stretching frequency at 1850 cm^{-1}, a region characteristic of a bridging carbonyl. Vibrational data for stepped surfaces support this interpretation. Another feature of the vibrational data for CO on Pt(III) supports the thesis that CO is on bridging sites. The described blank experiments coupled with a careful assessment of the coordination chemistry as a function of surface crystallography can eventually unravel the intimate features of metal surface coordination chemistry. 1 figure. (DP)

30997 Ion beam studies of organometallic chemistry. High energy sampling of reaction intermediates involved in carbon-carbon bond cleavage by transition metals. Armentrout, P.B.; Beauchamp, J.L. (California Inst. of Tech., Pasadena). *J. Am. Chem. Soc.;* **102**: No. 5, 1736-1738(27 Feb 1980).

Chemical transformation often involves reactive intermediates which correspond to local minima on a complex potential energy surface. In this study of the reactions of cobalt ions with alkanes, the intermediate is provided more energy than needed for reaction. The quantitative assessment of the fragmentation of reaction intermediates provided thermodynamic data. These investigations involved organo transition metal reactions using ion beam technqiues. Results for the reaction of Co^+ with 2-methylpropane and 2,2-dimethylpropane are included. The observation that the cross section for production of $CoCH_3^+$ is always greater than that of C_3H_7+ implies that $IP(C_0CH_3) < IP(iso\text{-}C_3H_7) = 7.36$ eV. A similar analysis of the 2,2-dimethylpropane system establishes $IP(CoCH_3) > IP(tert\text{-}C_4H_9) = 6.70$ eV. Measurement of the thresholds for the endothermic processes observed at high energies provides band energies of the products. Preliminary data for the endothermic reactions of Co^+ with hydrogen and ethane indicate that $D^0(Co^+\text{-}H) = 52 +- 4$ and $D^0(Co - CH_3) = 61 +- 4$ kcal/mol. Combined with the ionization potentials, $IP(CoH) = 7.3 +- 0.1$ and $IP(CoCH_3) = 7.0 +- 0.3$ EV; we find the neutral band dissociation energies, $D^0(CoH) = 39 +- 6$ and $D^0(CoCH_3) = 41 +- 10$ kcal/mol. The results provide substantial evidence for the viability of a mechanism for carbon-carbon bond cleavage of alkanes which involves direct insertion of a metal into the carbon-carbon band as a first step. Thermochemical data indicating strong metal-carbon bonds corroborate this hypothesis. 2 figures. (DP)

30998 Studies with amino acids. 1. Synthesis of valine. Davis, J.W. Jr. (Univ. of California, Berkeley). *J. Org. Chem.;* **43**: 3980-3982(1978).

Reactions for the preparation of amino acids, specifically valine, are described. The procedure is particularly applicable to the preparation of ^{11}C-labelled amino acids for in vivo metabolic studies. Potassium cyanide in anhydrous ether is reacted with isobutyraldehyde to yield 2-hydroxyisovaleronitrile (I). I is reacted with thionyl chloride at room temperature to yield 2-chlorosulfinyloxy-isolvaleronitrile (II) which is added dropwise to anhydrous ammonia in a dry ice-acetone bath to yield the amino acid. After the vigorous reaction is complete, the excess NH_3 is allowed to evaporate and the residue is refluxed with NaOH to yield valine. (BLM)

30999 (SAND—80-6010) Migration polymerization of acrylamide under shock-wave treatment. Ignatovich, T.N.; Yapol'skii, P.A.; Bragintseva, L.M. Translated from Russian *Vysokomol. Soedin., Ser. B;* **12**: 506-508(1970). 7p. NTIS, PC A02/MF A01.

On treatment of acrylamide with shock waves with amplitudes of 80 to 350 kbar, migrational polymerization with formation of poly-β-alanine proceeds along with vinyl polymerization. This phenomenon is accompanied by changes in the IR spectra which are associated with formation of secondary amide groups and loss of the tertiary carbon atom. The detection of β-alanine in the hydrolyzates of the samples by means of paper chromatography serves as evidence for migrational polymerization.

ELECTROCHEMISTRY

REFER ALSO TO CITATION(S) 30407

31000 Analysis of Gouy interference patterns from binary free-diffusion systems when the diffusion coefficient and refractive index have c/sup 1/2/ and C/sup 3/2/ terms, repsectively. Albright, J.G.; Miller, D.G. (Univ. of California, Livermore). Contract W-7405-ENG-48. *J. Phys. Chem.;* **84**: No. 11, 1400-1413(29 May 1980).

Gouy fringe patterns are treated by numerical intergration and analytical techniques for binary electrolyte systems whose diffusion coefficients D and refractive indices n have concentration dependences including 1/2 and 3/2 powers. If one initial solution is pure water, skewing from the ideal case (constant D, linear n) is substantial; correction factors are large; and no averages of experimental quantities will yield D(anti-C). Refractive-index effects were much larger than expected. Analytical results include extension of the Gosting-Fujita theory to yield fringe positions and proof that f(zeta)/sup 2/3/ is a proper extrapolation function to get D/sub A/. Numerical integration results show (1) that the Gosting-Onsager theory for ideal systems is better than previously believed at high fringe numbers or low total number of fringes, (2) that masks are more important than previously assumed, and (3) that calculated corrections to experimental quantities can be least squared successfully in terms of variables suggested by the analytical theory. As anti $C/(\Delta C/2)$ increases (C_0 moves away from infinite dilution), analytical results approach the numerical values. Proper analyses of dilute electrolyte data require several experiments to obtain the concentration-dependent correction factors. Examples for KCl and $CaCl_2$ are given. 4 figures, 4 tables.

PHOTOCHEMISTRY

REFER ALSO TO CITATION(S) 30731, 31172

31001 Method for producing rapid pH changes. Clark, J.H.; Campillo, A.J.; Shapiro, S.L.; Winn, K.R. US Patent Application 042,163. [nd]. 30p.

A method of initiating a rapid pH change in a solution comprises irradiating the solution with an intense flux of electromagnetic radiation of a frequency which produces a substantial pK change to a compound in solution. To optimize the resulting pH change, the compound being irradiated in solution should have an excited state lifetime substantially longer than the time required to establish an excited state acid-base equilibrium in the solution. Desired pH changes can be accomplished in nanoseconds or less by means of picosecond pulses of laser radiation.

31002 (BNL—28029) Picosecond spectroscopic search for electron transfer reactions in dimeric and trimeric reaction center models containing pyrochlorophyll/sub a/. Netzel, T.L.; Bucks, R.R.; Boxer, S.G.; Fujita, I. (Brookhaven National Lab., Upton, NY (USA); Stanford Univ., CA (USA). Dept. of Chemistry). 1980. Contract AC02-76CH00016. 3p. (CONF-800827—1). NTIS, PC A02/MF A01.

From 3. international conference on photochemical conversion and storage of solar energy; Golden, CO, USA (3 Aug 1980).

To further understanding of the light driven electron transfer reactions found in natural photosystems, dimeric and trimeric model molecules containing PChl/sub a/ were studied. The potential donor and acceptor subunits were covalently linked to form a single large molecule. The distance between the donor and acceptor subunits was altered by using both 10 atom and 5 atom chains. The effects of altering the relative orientation of the donor and acceptor were probed by contrasting the kinetics observed with added pyridine to those observed with added alcohol. Solvent dielectric (ϵ) effects were studied by using three solvents: toluene ($\epsilon = 2$), CH_2Cl_2 ($\epsilon = 9$) and CH_3CN ($\epsilon = 39$). Finally, the redox span of the potential photoproducts was also varied. Results are presented and discussed. Both PChl/sub a/ and PPheo/sub a/ give essentially the same fluorescence yield in the three solvents used, ~ 100 arbitrary counts.

31003 (LA-UR—80-1928) **Excited-state proton transfer kinetics in 1-naphthol compounds and organometallic complexes.** Shapiro, S.L.; Winn, K.R.; Clark, J.H. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 11p. (CONF-800656—3). NTIS, PC A02/MF A01.

From Picosecond meeting; Falmouth, MA, USA (18 Jun 1980).

In direct measurements of excited-state proton transfer kinetic of 1-naphthol compounds + organometallic complexes, sample purity is essential.

31004 **Picosecond photophysics of covalently linked pyrochlorophyllide a dimer. Unique kinetics within the singlet manifold.** Pellin, M.J.; Wasielewski, M.R.; Kaufmann, K.J. (Argonne National Lab., IL). *J. Am. Chem. Soc.;* **102**: No. 6, 1868-1873(12 Mar 1980).

The excited state absorption and fluorescence characteristcs of the folded configuration of bis(pyrochlorophyllide a) ethylene glycol diester were studied on a picosecond time scale. This model for the primary photochemical electron donor in photosystem I of green plants displayed photophyscial properties that were found to depend strongly on both solvent and temperature. First, at 290 K the fluorescence lifetime and the lifetime of the excited state absorbance changes following an 80-ps flash at 528 nm varied dramatically with a change in solvent, CH_2Cl_2 vs. CCl_4. At 290 K the absorbance changes of the dimer in CCl_4 showed a large positive optical density change at 660 nm and bleaching at 700 nm. The 660-nm positive optical density change was absent for the folded dimer dissolved in CH_2Cl_2. Second, similar dramatic lifetime variations were observed for folded dimer in CH_2Cl_2 as a function of temperature. Both fluorescence lifetimes and absorption change decay rates were very similar with a lifetime at 290 K of 110 ps increasing to 4.6 ns at 200 K. However, the quantum yield for fluorescence of the dimer remained relatively constant in the 290 to 200 K temperature range. As the sample of folded pyrochlorophyll a dimer in CH_2Cl_2 was cooled from 290 to 270 K the bleaching centered at 700 nm broadened somewhat and a new positive optical density change appeared at 660 nm. This spectrum was completely analogous to that obtained for the folded dimer in CCl_4 at 290 K. These results were interpreted in terms of a dual excited singlet state model with one singlet state fluorescent while the other remains nonfluorescent. Initial excitation of the dimer into the nonfluorescent state followed by a kinetically controlled population distribution between both excited states was shown to account for the data. 8 figures, 1 table.

RADIATION CHEMISTRY

REFER ALSO TO CITATION(S) 30974

31005 **Temperature dependence of the gas-phase self-reaction of HO_2 in the presence of NH_3.** Ruey-Rong Lii; Gorse, R.A. Jr.; Sauer, M.C. Jr.; Gordon, S. (Argonne National Lab., IL). *J. Phys. Chem.;* **84**: No. 8, 813-817(17 Apr 1980).

The dependence of the rate constant for the overall reaction $HO_2 + HO_2 \rightarrow$ products on temperature (290 to 400 K) and concentration of NH_3 is reported. Analysis of the results yields values of $\Delta H°_{298} = -13 +- 1.5$ kcal/mol and $\Delta G°_{298} = -3.3 +- 0.2$ kcal/mol for the formation of the HO_2-NH_3 complex.

31006 **Rate constant of the reaction of $O(^3P)$ with HO_2.** Ruey-Rong Lii; Sauer, M.C. Jr.; Gordon, S. (Argonne National Lab., IL). *J. Phys. Chem.;* **84**: No. 8, 817-819(17 Apr 1980).

The rate contant for the reaction of $O(^3P)$ with HO_2 is measured at 298 K by spectrophotometric observation of the HO_2 decay (230 nm) and the O_3 formation (265 nm) following irradiation of systems of ca. 3.6×10^{19} molecules of Ar cm^{-3}, 6.5×10^{18} molecules of H_2 cm^{-3}, and 1.6×10^{19}-6.5×10^{18} molecules of O_2 cm^{-3} with electron pulses. The rate constant obtained is $(7 +- 2) \times 10^{-11}$ cm^3 $molecule^{-1}$ s^{-1}.

31007 **Rate constant for the reaction of OH with HO_2.** Ruey-Rong Lii; Gorse, R.A. Jr.; Sauer, M.C. Jr.; Gordon, S. (Argonne National Lab., IL). *J. Phys. Chem.;* **84**: No. 8, 819-821(17 Apr 1980).

Spectrophotometric observation of both HO_2 and OH in pulse-irradiated Ar-H_2O-O_2 systems leads to a value of $k_1 = (0.99 +- 0.12) \times 10^{-10}$ cm^3 $molecule^{-1}$ s^{-1} at 308 K for the reaction $OH + HO_2 \rightarrow H_2O + O_2$.

31008 **Reduction of nitro blue tetrazolium by CO_2^- and O_2^- radicals.** Bielski, B.H.J.; Shiue, G.G.; Bajuk, S. (Brookhaven National Lab., Upton, NY). *J. Phys. Chem.;* **84**: No. 8, 830-833(17 Apr 1980).

The reduction of nitro blue tetrazolium (NBT^{2+}) by CO_2^- and O_2^- has been studied by the stopped-flow method and the pulse-radiolysis technique. Both reductants form the tetrazolinyl radical, and the rate constants are k/sub $NBT^{2+} + CO_2^-$/ $= (6.4 +- 0.2) \times 10^9$ M^{-1} s^{-1} and k/sub $NBT^{2+} + O_2^-$/ $= (5.88 +- 0.12) \times 10^4$ M^{-1} s^{-1}. In the absence of other reactants, the tetrazolinyl radicals (NBT^{+}.) disappear by a pH-dependent second-order disproportionation reaction to produce monoformazan (MF^+) and nitro blue tetrazolium (NBT^{2+}) ions. The tetrazolinyl radical (NBT^{+}.) has an absorption maximum at 405 nm with a pH-independent molar extinction coefficient ϵ/sub 405nm/ $= 15{,}000 +- 350$ M^{-1} cm^{-1}. Monoformazan (MF^+) has an absorption maximum at 530 nm; its molar extinction coefficient varies from ϵ/sub 530 nm/ $= 25{,}400 +- 1200$ M^{-1} cm^{-1} at pH 9.5-11.0 to ϵ/sub 530nm/ $= 12{,}800 +- 640$ M^{-1} cm^{-1} at pH 5.7-6.7. Mechanisms for the overall reaction are discussed.

31009 **Formation of ion pairs in rubidium-tetrahydrofuran crown ether solutions.** Eliav, U.; Levanon, H. (Univ. of Notre Dame, IN). *J. Phys. Chem.;* **84**: No. 8, 842-847(17 Apr 1980).

The effect of dicyclohexyl-18-crown-6 (CR) on the transient species formed in irradiated solutions (pulse radiolysis) of THF saturated with rubidium metal was investigated. Analysis of the kinetics and spectra of the transients reveals that, in addition to the metal anion Rb^-, the solvated monomer Rb., and the solvated electron e/sub s/$^-$, a new species attributed to an ion pair of the type ($RbCR^+$,e) is formed in solutions containing Cr. This species is characterized by its absorption spectrum and its formation by a second-order process, Rb. + CR $\rightleftharpoons$ ($RbCR^+$,e). The absorption spectrum of Rb. is peaked around 1250 nm and that of ($RbCR^+$,e) around 1800 nm, with molar extinction coefficients being 2.4×10^4 M^{-1} and 2.8×10^4 M^{-1}, respectively. It is concluded that the addition of CR to THF is equivalent to the increase in the donor number of the solvent in which the alkali metal is dissolved.

31010 **Free radicals. Chemistry of octane improvement. Advanced instrumentation for analysis of combustion products.** Rescorla, A.R. Washington, DC; American Chemical Society (1980). 214p. (CONF-800303—(Vol.25No.1)). Phillips Petroleum Co., Bartlesville, OK 74004.

From 179. national meeting of the American Chemical Society; Houston, TX, USA (23 Mar 1980).

Papers from three symposia are included: free radicals, chemistry of octane improvement, and advanced instrumentation for analysis of combustion products. Separate abstracts were prepared for 15 papers. (MCG)

31011 **Effect of gamma irradiation and forward bias on the 76 K electroluminescence spectrum of GaP:Zn,O.** Barnes, C.E. (Sandia Lab., Albuquerque, NM). Contract DE-AC04-76-DP00789. *J. Electron. Mater.;* **8**: No. 3, 377-389(1979).

Both the effects of gamma irradiation and high-current forward bias on the low temperature electroluminescence (EL) spectra of GaP:Zn,O light emitting diodes (LEDs) have been studied by measuring constant current (1 mA) 76 K EL spectra below 1000 nm. The LEDs were divided into two sets: a control set which was subjected only to forward bias, and a set exposed to gamma irradiation and forward bias. The EL spectra reveal the growth of sharp, bound exciton emission bands (Z lines) in the range 580 nm to 620 nm following extended high current bias at 300 K of irradiated LEDs and, more weakly, in control LEDs which show pre-bias evidence of these lines. The emergence of these lines is tenatively associated with the recombination-enhanced motion of a defect, possibly the Zn interstitial, which can be introduced by irradiation and is sometimes present in unirradiated LEDs.

RADIOCHEMISTRY AND NUCLEAR CHEMISTRY

PROPERTIES OF RADIOACTIVE MATERIALS

REFER ALSO TO CITATION(S) 30622, 30982, 30998

31012 **Quasi-relativistic SCF Xα study of octahedral $5f^1$ complexes.** Thornton, G.; Roesch, N.; Edelstein, N. (Univ. of California, Berkeley). *Inorg. Chem.;* **19**: No. 5, 1304-1307(May 1980).

Quasi-relativistic SCF Xα calculations have been carried out for the octahedral $5f^1$ complexes Pa/sup IV/X_6^{2-}, U/sup V/X_6^- (X = F, Cl, Br, I), and Np/sup VI/F_6. The $5f \rightarrow 5f$ excitation energies calculated by using the transition-state method agree well with the available absorption spectra. Ionic effects appear to dominate the trends observed in the f-orbital ligand field splitting.

31013 **Structure of tris(urea)dioxouranium(VI) sulfate, $UO_2(OC(NH_2)_2)_3SO_4$.** Ruben, H.; Spencer, B.; Templeton, D.H.; Zalkin, A. (Univ. of California, Berkeley). Contract W-7405-ENG-48. *Inorg. Chem.;* **19**: No. 3, 776-777(Mar 1980).

As part of a study of structures of uranium complexes the crystal structure of tris(urea)uranyl sulfate was determined by single-crystal x-ray diffraction methods. The uranyl ion is coordinated to oxygen atoms from the three urea molecules and from the sulfate ions in a pentagonal-bipyramid arrangement in which the pentagonal bipyramids are bridged by the sulfate ions to form an infinite chain.

This result is in contrast to the structure of pentakis(urea)dioxouranium(VI) dinitrate in which the oxygen atoms of the five urea molecules are coordinated to the uranyl ion to form discrete complexes with the same pentagonal-bipyramidal geometry; the nitrate ions are not coordinated to the uranyl ion. 1 figure, 4 tables. (DP)

31014 Portable fluorometric monitor for detection of surface contamination by polynuclear aromatic compounds. Schuresko, D.D. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Anal. Chem.;* **52**: No. 2, 371-373(Feb 1980).

Uptake of polynuclear aromatic hydrocarbon (PNA) compounds via contact with contaminated surfaces in the workplace has been identified as a major mode of worker exposure. An instrument to monitor PNA buildup on surfaces must be capable of: (a) functioning duning actual plant operation in varied working environments; (b) detecting material spilled on different work surfaces, including machinery, plumbing, construction materials, and on personnel and clothing; and (c) being easily and reliably operated by all plant personnel. The fluorescence spotter described in this paper has these capabilities. It consists of a hand-held optics unit connected via an umbilical cable to an electronics cansole, enables remok monitoring of work area surfaces at distances $\leqq$ 3m. The new developed spotter (a) can be operated outdoors in direct sunlight or indoors in the presence of strong background illunination; (b) can provide a quantitative measure of the amount of fluorescent material; (c) will discriminate between the fluorescence of organic materials and some inorganic compounds based on their fluorescence lifetime; and (d) does not present a vision hazard to personnel. The spotter has been laboratory tested with pure compounds and with several coal and oil shale products and wastes. The spotter is capable of discriminating between classes of organic contaminants, such as PNAs and acridine dyes, by selecting optiman excitation and emission wavelengths with optical fibers. It can also discriminate the fluorescence of inorganic materials such as uranyl nitrate from the fluorescence of organic compounds. This spotter is suitable for the work-area surface monitoring required by the coal conversion and oil shale industries. 3 figures, 2 tables.

RADIOISOTOPE PRODUCTION

REFER ALSO TO CITATION(S) 30248

31015 Production of ^{123}I in the LASL radiochemistry hot cells. Barnes, J.W.; Bentley, G. (Los Alamos Scientific Lab., NM). pp 292-294 of Proceedings of the 27th conference on remote systems technology. Wallin, D.R. (ed.). La Grange Park, IL; American Nuclear Society, Inc. (1980).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

A relatively simple and inexpensive, glass, high-vacuum system capable of handling wet chemistry has been set up and operated in a hot cell to establish the feasibility of a process for obtaining the medically useful isotope ^{123}I. One production run with a proton-irradiated La_2O_3 target resulted in useful quantities of ^{123}I in reasonable purity. The ^{127}Xe also produced in this target is obtained in a usable form after short-lived ^{123}Xe and ^{125}Xe have decayed and a second purification from their iodine daughters is completed.

31016 Production of ^{123}I in the LASL radiochemistry hot cells. Barnes, J.W.; Bentley, G.E. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* **33**: 922(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31017 Evolution of LAMPF-produced medically useful radioisotopes. Bentley, G.E.; Barnes, J.W.; Grant, P.M.; O'Brien, H.A. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* **33**: 229(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

COMBUSTION, PYROLYSIS, AND HIGH-TEMPERATURE CHEMISTRY

REFER ALSO TO CITATION(S) 31010

31018 (SAND—79-8805) **Effects of selective diffusion on the stability of burner-stabilized premixed flames.** Margolis, S.B. (Sandia Labs., Livermore, CA (USA)). Dec 1979. Contract AC04-76DP00789. 34p. (CONF-800809—2). NTIS, PC A03/MF A01.

From 18. combustion symposium; Waterloo, Canada (17 Aug 1980).

The effects of selective diffusion, or multiple Lewis numbers, on the one-dimensional stability of an isobaric burner-stabilized premixed flame is investigated for arbitrary stoichiometry and reaction order in the asymptotic limit of large activation energy. Utilizing a global reaction model of the form ν/sub f/F + ν/sub o/O $\rightarrow$ ν/sub p/P, the author has recently shown that, unlike most adiabatic flames, many burner-stabilized flames are unstable to arbitrarily small normal mode disturbances under easily achievable conditions. In particular, when certain parameters pass through critical values, the nontrivial steady-state solution undergoes a supercritical Hopf bifurcation to a pulsating, or time-oscillating, solution branch. In the present work, the previous restrictive assumption that Le/sub f/ = Le/sub o/ is relaxed to allow for unequal diffusion of fuel and oxidizer. This results in a number of interesting and significant effects (which are absent when Le/sub f/ = Le/sub o/) on the location of the stability boundary in parameter space. The results are particularly relevant to complex hydrocarbon flames, where the heavier hydrocarbon fuel may have a significantly higher Lewis number than the oxidizing species.

31019 (SAND—79-8831) **OH rotational temperature from two-line laser excited fluorescence.** Cattolica, R.J. (Sandia National Labs., Livermore, CA (USA)). Jun 1980. Contract AC04-76DP00789. 17p. (CONF-800712—4). NTIS, PC A02/MF A01.

From 15. AIAA thermophysics conference and 13. AIAA fluid and plasma dynamics conference; Snowmass, CO, USA (14 Jul 1980).

A two-line laser excited fluorescence technique has been developed to measure the rotational temperature of the OH molecule. This technique eliminates problems encountered in the application of other laser fluorescence methods for measuring the OH temperature in combustion environments such as: fluorescence trapping, nonequilibrium excited state population, spectral bandwith sensitivity, and quenching. The technique consists of exciting a specific rotational level in the $A^2\Sigma(v' = 0)$ excited state from two different rotational levels in the $X^2PI(v'' = 0)$ ground state of the OH molecule using a tunable dye laser and monitoring the broad band fluorescence. An example of the implementation of this technique in an atmospheric pressure methane-air flat flame is included. The possible application of this technique in turbulent combustion is also evaluated.

31020 (SAND—80-8223) **Fundamental combustion and diagnostics research at Sandia. Progress Report from January-March 1980.** Hartley, D.L.; Gusinow, M.A. (Sandia Labs., Livermore, CA (USA)). Jun 1980. Contract AC04-76DP00789. 43p. NTIS, PC A03/MF A01.

The combustion research at Sandia Laboratories sponsored by the Office of Basic Energy Sciences (OBES) emphasizes basic research into fundamental problems associated with combustion. Special emphasis is placed on the development and application of advanced research methods. The overall program addresses: (1) detailed chemistry of combustion, (2) fundamental processes associated with laminar and turbulent flames, (3) development of research techniques specifically applicable to combustion environments, and (4) operation of the user-oriented Combustion Research Facility. This report presents status reports on the research sponsored by OBES. The first section contains activities in Combustion Research, the second section contains activities in Molecular Physics and Spectroscopy, and the third section contains activities in Diagnostics Research.

31021 (SAND—80-8640) **Crossed-beam, background-free CARS measurements in a methane diffusion flame.** Farrow, R.L.; Mattern, P.L.; Rahn, L.A. (Sandia Labs., Livermore, CA (USA)). Jun 1980. Contract AC04-76DP00789. 17p. (CONF-800808—4). NTIS, PC A02/MF A01.

From 7. international conference on raman spectroscopy; Ottawa, Canada (4 Aug 1980).

A crossed-beam, background-free CARS configuration has been used to probe the flame front of a methane diffusion flame. Preliminary results are reported that demonstrate an enhanced signal-to-noise ratio and an increase in spatial resolution in comparison with conventional CARS experiments.

31022 (UCRL—84653) **Chemical kinetics and modeling of combustion processes.** Westbrook, C.K.; Dryer, F.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.; Princeton Univ., NJ (USA)). 18 Jul 1980. Contract W-7405-ENG-48; AS02-77ET11287. 49p. (CONF-800809—4). NTIS, PC A03/MF A01.

From 18. combustion symposium; Waterloo, Canada (17 Aug 1980).

This paper reviews the mechanisms used for the combustion of hydrocarbon fuels and some of the practical problems to which they have been applied. Chemical kinetic reaction mechanisms are strongly hierarchical in that mechanisms for the combustion of more complex fuels contain within them submechanisms for simpler fuel molecules. With this basic structure in mind, mechanisms for H_2-O_2, CO, CH_4, and CH_3OH are discussed, followed by C_2 species including ethane, ethylene, and acetylene, and finally by a single C_3 species, propane. Validation of the elementary reactions and rates in

a reaction mechanism is strongly influenced by the combustion environment being studied. For this reason, we emphasize comprehensive reaction mechanisms developed using data from a variety of experimental systems. We review some of the principles and techniques involved in the development and application of these kinetics models for hydrocarbon fuels. Applications of reaction mechanisms to combustion systems include purely kinetic problems and others requiring a treatment of transport effects. The former class includes shock tubes, plug flow reactors, and stirred reactors, while the latter includes laminar flame propagation, flame quenching, and flame inhibition. Each of these combustion systems is discussed, emphasizing the role of chemical kinetics.

ENGINEERING

GENERAL ENGINEERING

REFER ALSO TO CITATION(S) 30834

FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 31322

31023 (BDX—613-2382) **Deburring: technical capabilities and cost-effective approaches. Lessons 5 and 6.** Gillespie, L.K. (Bendix Corp., Kansas City, MO (USA)). Jun 1980. Contract AC04-76DP00613. 90p. NTIS, PC A05/MF A01.

The ten-lesson text on deburring is designed to provide engineers and production supervisors with an overall understanding of deburring economics and current capabilities. Lessons 5 and 6 show that the effective plant-wide reduction of deburring costs can best be achieved by: determining the people who should be involved in a plant-wide review of deburring; defining the approach to be used in a plant-wide review of deburring; providing some form of training for both engineers and production workers; establishing in-plant standards for burrs and deburring; and understanding the capabilities of the available deburring equipment. The key to plant-wide control of deburring costs lies in considering deburring as integral as drilling or milling to the manufacturing process, in respecting the difficulty that deburring presents, in recognizing those who contribute to the success of deburring operations, and in using the large quantity of data that already exists. Plant-wide control of deburring costs is the difference between 25 years of experience and one year of experience repeated 25 times.

31024 (BDX—613-2437) **Deburring: technical capabilities and cost-effective approaches. Lessons 7 and 8.** Gillespie, L.K. (Bendix Corp., Kansas City, MO (USA)). Jun 1980. Contract AC04-76DP00613. 55p. NTIS, PC A04/MF A01.

This ten-lesson text on deburring is designed to provide engineers and production supervisors with an overall understanding of deburring economics and current capabilities. Chapter 7 discusses deburring techniques. Electropolish and electrochemical deburring (ECD) are not the answer to everyone's deburring problems. They are high technology processes when compared to tumbling processes. They require more care, skill, and knowledge than many of the older processes. They are not mass finishing processes. In contrast, they can deburr areas totally untouchable by other processes, and electropolish can produce brilliant finishes. ECD selectively works only in one area, and neither process exerts cutting forces which would distort thin sections. ECD is applicable to all metals and all sizes of burrs. Once established, both processes can be controlled by unskilled help.

31025 (SAND—80-1648C) **Reentry-vehicle flight testing and recovery techniques. Paper AIAA-80-1455.** Rigali, D.J.; Sterk, M.W.; Randmaa, J. (Sandia National Labs., Albuquerque, NM (USA); Air Force Ballistic Missile Office, Norton AFB, CA (USA)). 1980. Contract AC04-76DP00789. 12p. (CONF-800712—3). NTIS, PC A02/MF A01.

From 15. AIAA thermophysics conference and 13. AIAA fluid and plasma dynamics conference; Snowmass, CO, USA (14 Jul 1980).

A technique to soft-recover high ballistic coefficient reentry vehicles from ICBM reentry conditions has been developed and demonstrated. To date, two different types of vehicles have been soft-recovered, utilizing the mass jettison, parachute recovery technique described. The fabrication and assembly of two additional RVs of different designs are presently underway in preparation for flight test. A technique to allow an increase in the severity of the environment from which an RV can be recovered is presently being analyzed and ground-tested with plans to flight-test it within two years. Descriptions of all of these vehicles and a summary of the flight-test results are presented.

CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES

REFER ALSO TO CITATION(S) 30600, 30617, 31321, 31378, 31379

HANDLING EQUIPMENT AND PROCEDURES

REFER ALSO TO CITATION(S) 30245, 30246, 30249, 30253, 30254, 30281, 31015, 31105, 31106

31026 **History of remote handling at Los Alamos.** Wood, W.T.; Wilson, M.T.; Barnes, J.W. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* **33**: 867(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31027 (RFP—2998) **Quantitative study of mixing in annular and raschig ring filled tanks.** Fredrickson, M.A. (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). 14 Jul 1980. Contract AC04-76DP03533. 31p. NTIS, PC A03/MF A01.

A quantitative study of mixing, which utilized the exit age distribution theory, has been completed for bench-scale annular and raschig ring filled tanks, in addition to a pilot-scale annular tank. A study of mixing and fluid flow in a full-scale, single-entry, raschig ring filled tank also was initiated. Results showed the bench-scale raschig ring filled tank approached plug-flow (no mixing) behavior. In a bench-scale annular tank, regardless of whether fluid entered tangentially or nontangentially, the vessel approached continuously stirred tank reactor behavior (perfect mixing). The pilot-scale annular tank approached continuously stirred tank reactor behavior only when tangential entry was used. Mixing in the full-scale raschig ring filled tank he tank did not approach eithr the perfect or the no mixing situations. Instead, the tank had a flow pattern in which solution channeled through a small volume of the tank, leaving the regions outside the channel effectively inactive.

31028 **Hot cells for physical testing at the Oak Ridge National Laboratory.** Dismuke, S.E.; King, E.M.; Lines, R.L.; Walls, A.A. (Oak Ridge National Lab., TN). pp 82-85 of Proceedings of the 27th conference on remote systems technology. Wallin, D.R. (ed.). La Grange Park, IL; American Nuclear Society, Inc. (1980).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

The first hot cell at the Oak Ridge National Laboratory for physical testing of radioactive material began operation in 1945. Since then several additional facilities have been constructed and others have been modified for this purpose. Four facilities with wide examination capabilities are currently in operation. Equipment includes mechanical disassembly, metallography, mechanical property (creep, tensile, impact, fatigue), x-ray diffraction, x radiography, electron microprobe, scanning electron microscope, gamma energy analyzers, gas sampler and analyzer, pycnometers, analytical balances, dimensional equipment, and others.

31029 **Hot cell extension optical profilometer.** Lazarus, M.E. (Los Alamos Scientific Lab.); Mason, P.A. pp 217-220 of Proceedings of the 27th conference on remote systems technology. Wallin, D.R. (ed.). La Grange Park, IL; American Nuclear Society, Inc. (1980).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

An optical profilometer for an alpha-gamma containment cell, utilizing a Techmet LaserMike focusing laser beam optical micrometer, has been installed at the Los Alamos Scientific Laboratory Wing 9 hot cell facility. The system uses a hot cell extension chamber, shielded with depleted uranium, to provide the nominal 30-cm (12-in.) working distance required by the LaserMike, and to keep the LaserMike components outside the radiation-contamination environment. System accuracy is better than +-5 μm (0.0002 in.) on diameters between 2 and 13 mm (0.08 and 0.5 in.).

31030 **In-cell ultrasound inspection of two cadmium thermal-neutron filters.** Holland, J.W. (Argonne National Lab., IL); Brown, BW. pp 231-234 of Proceedings of the 27th conference on remote systems technology. Wallin, D.R. (ed.). La Grange Park, IL; American Nuclear Society Inc. (1980).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

Ultrasound inspection techniques were employed to nondestructively examine the integrity of chemical and mechanical bonds within two thermal-neutron filter (TNF) assemblies containing cadmium and Type 316 stainless steel. Conventional ultrasound instrumentation in conjunction with existing hot cell equipment was utilized for the remote inspection of these activated materials at the Hot Fuel Examination Facility/North(HFEF/N). The TNF assembly was attached to the bed of the HFEF/N disassembly mill, and a contact ultrasound transducer was mounted into a spring-loaded

alignment fixture that was attached to the vertical mill head. Coaxial cables attached the transducer to the out-of-cell instrumentation (a Caliper 105-H/L signal conditioner). Four-hundred inspections were completed on each TNF.

31031 Shielded cubicle and equipment for examination of coated fuel particles. Dismuke, S.E. (Oak Ridge National Lab., TN). pp 257-264 of Proceedings of the 27th conference on remote systems technology. Wallin, D.R. (ed.). La Grange Park, IL; American Nuclear Society Inc. (1980).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

The gamma spectrum of microspheres, the fuel of high-temperature gas-cooled reactors, is examined to determine the probable failure fraction of that fuel. A unique irradiated-microsphere gamma analyzer automatically classifies thousands of particles. The specialized equipment needed for handling the large number of particles to be examined is housed in a shielded manipulator cell with inert atmosphere capabilities. The cell is vibration isolated for the stability needed for the shielded scanning electron microscope and steromicroscope.

31032 Remote handling design for the intense pulsed neutron source. Swanson, N.J.; Ball, J.R.; Hamer, E.E. (Argonne National Lab., IL). pp 330-338 of Proceedings of the 27th conference on remote systems technology. Wallin, D.R. (ed.). La Grange Park, IL; American Nuclear Society, Inc. (1980).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

Spent, highly radioactive uranium targets from the intense pulsed neutron source will require remote handling for removal and replacement. Remote handling will also be needed for components of the facility that become activated from interaction with high-energy protons and neutrons. The remote handling techniques and equipment for these operations have been designed with particular emphasis on simplicity and efficiency.

31033 History and status of the Hot Fuel Examination Facility (HFEF) Complex. Bacca, J.P. (Argonne National Lab., Idaho Falls, ID). *Trans. Am. Nucl. Soc.;* **33**: 868(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31034 Alpha-gamma hot cell facility at Argonne-East. Neimark, L.A.; Jackson, W.D.; Donahue, D.A. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **33**: 869-870(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31035 Present Babcock and Wilcox Hot Cell Facility. Beauregard, R.J.; Womack, R.E. (Babcock and Wilcox Co., Lynchburg, VA). *Trans. Am. Nucl. Soc.;* **33**: 870-871(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31036 Capabilities and application of existing hot cells at the Hanford Engineering Development Laboratory. Pember, L.A.; Gruber, W.J.; McMahan, M.E.; Weber, E.T. (Hanford Engineering Development Lab., Richland, WA). *Trans. Am. Nucl. Soc.;* **33**: 871-872(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31037 Vallecitos Nuclear Center hot cells. Butler, R.E. (General Electric Co., Pleasanton, CA); Hall, T.C.; Dutina, D. *Trans. Am. Nucl. Soc.;* **33**: 872-873(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31038 Battelle Hot Cell Laboratory. Klingensmith, R.W. (Battelle Columbus Labs., Columbus, OH). *Trans. Am. Nucl. Soc.;* **33**: 873-874(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31039 Hot cells for physical testing at the Oak Ridge National Laboratory. Dismuke, S.E.; King, E.M.; Lines, R.L.; Walls, A.A. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **33**: 880-881(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31040 Radioactive Materials Analytical Laboratory. Laing, W.R.; Corbin, L.T. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **33**: 881(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31041 General Atomic Hot Cell modification and refurbishment. Steibel, J.S.; Johnson, H.O. (General Atomic Co., San Diego, CA). *Trans. Am. Nucl. Soc.;* **33**: 881-882(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31042 Current status of the Transuranium Processing Plant. King, L.J. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **33**: 882-883(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31043 Neutron radiography at the Hot Fuel Examination Facility. Richards, W.J.; McClellan, G.C. (Argonne National Lab., Idaho Falls, ID). *Trans. Am. Nucl. Soc.;* **33**: 903-904(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31044 Hot cell measuring and test equipment calibration control. Taylor, K.J. (Argonne National Lab., Idaho Falls, ID). *Trans. Am. Nucl. Soc.;* **33**: 904-905(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31045 Hot cell extension optical profilometer. Lazarus, M.E.; Mason, P.A. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* **33**: 907-908(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31046 Multiservice utility plug for remote fuel processing. Goldmann, L.H. Jr. (Hanford Engineering Development Laboratory, Richland, WA); Jensen, D.A. *Trans. Am. Nucl. Soc.;* **33**: 908-909(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31047 In-cell ultrasound inspection of two cadmium thermal-neutron filters. Holland, J.W. (Argonne National Lab., IL); Brown, B.W. *Trans. Am. Nucl. Soc.;* **33**: 911-912(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31048 Systematic approach to remote maintenance in the Fuels and Materials Examination Facility. Frandsen, G.B. (Hanford Engineering Development Lab., Richlamd, WA); Nash, C.R.; Divona, C.J.; May, R.F. *Trans. Am. Nucl. Soc.;* **33**: 912-913(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31049 Pneumatic system for transferring radioactive samples at Savannah River Laboratory. Carpenter, J.A. (E.I. duPonte de Nemours and Co., Aiken, SC). *Trans. Am. Nucl. Soc.;* **33**: 914-915(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31050 System for receiving and shearing LWR spent fuel. Siemens, D.H.; Berger, D.N.; Carter, J.G. (Battelle Columbus Labs., Columbus, OH). *Trans. Am. Nucl. Soc.;* **33**: 915-916(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31051 Shielded cubicle and equipment for examination of coated fuel particles. Dismuke, S.E. (Oak Ridge National Lab., TN). *Trans. Am. Nucl. Soc.;* **33**: 916-917(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31052 Rigid hoist articulated grapple system development for enhanced remote maintenance. Witham, C. (MB Associates, San Ramon, CA); White, P.; Garin, J. *Trans. Am. Nucl. Soc.;* **33**: 918-919(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31053 Maintenance and refurbishment of oil-filled lead glass shielding windows. Falkwarf, C.D. (Chem-Nuclear Systems Inc., Bellevue, WA). *Trans. Am. Nucl. Soc.;* **33**: 919-920(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31054 Hot cell for synthesis of labeled organic compounds. Ruth, T.J.; Fowler, J.S.; Karlstrom K.; MacGregor, R.; Sceviour, W.; Lambrecht, R.M.; Wolf, A.P. (Brookhaven National Lab., Upton, NY). *Trans. Am. Nucl. Soc.;* **33**: 927(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31055 Design and construction of the Fuels and Materials Examination Facility. Burgess, C.A. (Hanford Engineering Development Lab., Richland, WA). *Trans. Am. Nucl. Soc.;* **33**: 931-932(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31056 Laboratory-scale shielded cell for ^{252}Cf. Anderl, R.A.; Cargo, C.H. (EG and G Idaho, Inc., Idaho Falls, ID). *Trans. Am. Nucl. Soc.;* **33**: 932-933(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31057 Remote handling design for the intense pulsed-neutron source. Swanson, N.J.; Ball, J.R.; Hamer, E.E. (Argonne National Lab., IL). *Trans. Am. Nucl. Soc.;* **33**: 930-931(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31058 Neutron radiography at the Hot Fuel Examination Facility. Richards, W.J.; McClellan, G.C. (Argonne National Lab., Idaho Falls, ID). pp 203-208 of Proceedings of the 27th conference on remote systems technology. Wallin, D.R. (ed.). La Grange Park, IL; American Nuclear Society, Inc. (1979).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

A neutron radiography facility (NRAD) was recently installed in the Argonne National Laboratory Hot Fuel Examination Faciity. The NRAD is designed specifically for neutron radiography of irradiated reactor fuels and structural components that are being inspected in the hot cell. The source for NRAD is a 250-kW TRIGA-type nuclear reactor. The NRAD facility became operational in March 1978, and since that time over 1600 irradiated specimens have been neutron radiographed. Internal features such as fuel pellet cracking and separation, isotopic distribution, and evidence of fuel melting and redistribution are identified and evaluated from the neutron radiographs.

31059 Eddy-current cladding integrity testing and data analysis at HFEF/N. Franklin, E.M.; Phipps, R.D. (Argonne National Lab., Idaho Falls, ID). pp 212-216 of Proceedings of the 27th conference on remote systems technology. Wallin, D.R. (ed.). La Grange Park, IL; American Nuclear Society, Inc. (1979).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

At the Hot Fuel Examination Facility/North, irradiated fuel elements are examined by an eddy-current method to provide data on cladding condition. This method employs differential encircling coils coupled to an Automation Industries EM-3300 eddy-current tester to determine the size, depth, and location of cladding defects.

SHIPPING CONTAINERS

REFER ALSO TO CITATION(S) 30238, 30312

31060 (GA-A—15828) **Evaluation of FSV-1 cask for the transport of LWR irradiated fuel assemblies.** (General Atomic Co., San Diego, CA (USA)). May 1980. Contract AT03-80SF10791. 180p. (TTC—0119). NTIS, PC A09/MF A01.

The Model FSV-1 spent fuel shipping cask was designed by General Atomic Company (GA) to service the Fort St. Vrain (FSV) nuclear generating station, a High Temperature Gas Reactor (HTGR) owned and operated by Public Service Company of Colorado (PSC). This report presents an evaluation of the suitability of the FSV-1 cask for the transport of irradiated Light Water Reactor (LWR) fuel assemblies from both Pressurized Water Reactors (PWR) and Boiling Water Reactors (BWR). The FSV-1 cask evaluation parameters covered a wide spectrum of LWR fuel assemblies, based on burnup in Megawatt Days/Metric Ton of Heavy Metal (MWD/MTHM) and years of decay since irradiation. The criteria for suitability included allowable radiation dose rates, cask surface and interior temperatures and the Gross Vehicle Weight (GVW) of the complete shipping system.

TRANSPORT AND STORAGE FACILITIES

REFER ALSO TO CITATION(S) 31438

LASERS

REFER ALSO TO CITATION(S) 31320

31061 (BDX—613-2448) **Laser applications. Final report.** Horn, R.T. (Bendix Corp., Kansas City, MO (USA)). Jul 1980. Contract AC04-76DP00613. 45p. NTIS, PC A03/MF A01.

Processes were developed that use lasers as manufacturing tools. These processes were stripping of insulation from cables and wires, machining of quartz, microdrilling and welding of reflective metals, and precision alignment of curved surfaces before machining. A technological basis also was formed which resulted in a process for automatic surface inspection of parts and aided development of machining processes for Kevlar parts.

31062 (DOE/DP/40006—1) **Fusion driver study. Final technical report, April 1, 1978-March 31, 1980.** Friedman, H.W. (Avco-Everett Research Lab., Inc., Everett, MA (USA)). Apr 1980. Contract AC08-78DP40006. 338p. NTIS, PC A15/MF A01.

A conceptual design of a multi-megajoule, repetitively pulsed CO_2 laser system for Inertial Confinement Fusion is presented. System configurations consisting of 50 to 100 kJ modules operating at subatmospheric pressures with multiple pass optical extraction appear feasible with present or near term technology. Overall laser system efficiencies of greater than 10% at repetition rates in excess of 10 Hz are possible with the state-of-the-art pulsed power technology. The synthesis of all the laser subsystems into a specific configuration for a Laser Fusion Driver depends upon the reactor chamber(s) layout, subsystem reliability and restrictions on overall dimensions of the fusion driver. A design is presented which stacks power amplifier modules in series in a large torus with centrally located reactor chamber. Cost estimates of the overall Laser Fusion Driver are also presented.

31063 (DOE/DP/40054—1) **High power laser and materials investigation. Final report, 31 July 1978-28 October 1979.** Chicklis, E.P.; Folweiler, R.C.; Pollak, T.M.; Baer, J. (Sanders Associates, Inc., Nashua, NH (USA). Defensive Systems Div.). Jun 1980. Contract AC08-78DP40054. 162p. NTIS, PC A08/MF A01.

This is a combined study of resonant pumped solid state lasers as fusion drivers, and the development of crystalline optical materials suitable for propagation of the high peak powers associated with laser fusion research. During this period of study the concept of rare gas halide lasers was first demonstrated by the lasing of Tm:YLF at 453 nm pumped by the 353 nm energy of XeF. Excited stata densities of 5×10^{18} cm^{-3} have been attained and spectroscopic measurements show that up to 60% of the pump energy can be converted into useful stored energy. Alternative lasers and pumping schemes are also discussed. In all cases the potential RGH/SS systems are evaluated in respect to internal efficiency and heat loading.

31064 (DOE/ER/10522—1) **Experiments with very high-power lasers. Report of a workshop, November 29-30, 1979.** (Rochester Univ., NY (USA). Lab. for Laser Energetics). 1979. Contract AC02-79ER10522. 39p. NTIS, PC A03/MF A01.

Among possible experiments of general interest in physics are the study of the spectroscopy and cross section measurements of highly ionized species, the study of nuclear conversion processes, vacuum-ultraviolet lasers, multiphoton absorption, and the Kapitza-Dirac effect. Shock waves driven by ultrahigh-power lasers are capable of attaining pressures of the order of 1 to 4 TPa in material targets, providing a means of deriving equation-of-state data under such extreme conditions. Modifications observed in the structures of materials subjected to high-power laser radiation can lead to studies of damage and phase change processes. Classes of useful experiments in this area are given. The x rays produced when a pulse of ultrahigh-power laser radiation is focussed on a target are sufficiently intense to generate diffraction patterns and EXAFS spectra on a nanosecond time scale. A major application of ultrahigh-power lasers to chemistry and biology may consist in such time-resolved diffraction and EXAFS studies of dynamical systems. The laser systems at the National Laser User Facility at the University of Rochester are described. These systems are available to qualified investigators for user experiments.

31065 (DOE/ES/04199—1) **Experimental studies of electron impact depopulation of excited states of atoms: applications to laser development for fusion and isotope separation. Final report, 1 January 1977-30 June 1979.** Lubell, M.S. (Yale Univ., New Haven, CT (USA)). Jun 1980. Contract AS02-77DP40079. 24p. NTIS, PC A02/MF A01.

Motivated by the need for measurements of metastable depopulation mechanisms of Ar and Kr in the KrF rare-gas monohalide excimer laser, an ultra-high vacuum triple crossed-beams apparatus has been designed, fabricated, and assembled for the purpose of studying electron scattering from excited states of Ar and Kr atoms. A beam of metastable rare gas atoms, produced by near-resonant charge transfer of rare gas ions with alkali neutral atoms, is crossed by an electron beam and a far-red laser beam along mutually orthogonal axes. A hemispherical electron monochromator-spectrometer pair is used to measure the cross section for electron

scattering from the $2p_0$ excited state of the rare gas atom. Testing of parts of the assembled apparatus has been completed.

31066 (SAND—80-1486) **Three body ion-ion recombination coefficients for rare-gas-halogen mixtures.** Hoffman, J.M.; Moreno, J.B. (Sandia National Labs., Albuquerque, NM (USA)). Aug 1980. Contract AC04-76DP00789. 63p. NTIS, PC A04/MF A01.

Three body ion-ion recombination coefficients at 300 K are calculated for the process $R^+ + S^- + T \rightarrow RS/sup\ */ + T$ (R = Ne, Ar, Kr, Xe, Ar_2, Kr_2, Xe_2; S = F, Cl, Br, I; T = He, Ne, Ar, Kr, Xe), for buffer gas (T) pressures from ~ 0 to 30 atmospheres. Recombination coefficients are also calculated for $NeKr^+$, $ArKr^+$, $NeXe^+$, $ArXe^+$ and $KrXe^+$ with each of the negative halogen ions in a buffer gas which is one or the other of the positive-ion constituents.

31067 High-efficiency energy extraction in backward-wave Raman scattering. Jacobs, R.R.; Goldhar, J.; Eimerl, D.; Brown, S.B.; Murray, J.R. (University of California Lawrence Livermore Laboratory, Livermore, California 94550). W-7405-ENG-48. *Appl. Phys. Lett.;* 37: No. 3, 264-266(1 Aug 1980).

Pump depletions of 70—75% have been demonstrated for a KrF-laser-driven, methane-gas-filled backward Raman amplifier and are in agreement with predictions of the Frantz-Nodvik saturated-amplifier model. The associated counterpropagating Stokes laser intensity is determined to be > or ≈3.5 times that of the pump; the corresponding pulse compression ratio is ≃5.

31068 Generation of high-spectral-brightness tunable XUV radiation at 83 nm. Egger, H.; Hawkins, R.T.; Bokor, J.; Pummer, H.; Rothschild, M.; Rhodes, C.K. (Department of Physics, University of Illinois at Chicago Circle, Chicago, Illinois 60680). DE-AC02-80ET33065.A000;DE-A02-79-ER-10350. *Opt. Lett.;* 6: No. 7, 282-284(Jul 1980).

High-spectral-brightness coherent XUV radiation has been produced by third-harmonic generation of a transform-limited-bandwidth KrF^* laser in gaseous xenon. The observed XUV output, which was continuously tunable from 82.8 to 83.3 nm, had a peak power of 40 mW, a bandwidth $<0.01\ cm^{-1}$, and absolute frequency control to within $0.04\ cm^{-1}$. The utility of this XUV source for high-resolution spectroscopic application is demonstrated by absorption studies in molecular hydrogen.

31069 Multiple excitation regenerative amplifier inertial confinement system. George, V.E.; Haas, R.A.; Krupke, W.F.; Schlitt, L.G. (to Dept. of Energy). US Patent 4,205,278. 27 May 1980. Filed date 11 Jan 1978. 22p.

PAT-APPL-868,639.

The invention relates to apparatus and methods for producing high intensity laser radiation generation which is achieved through an optical amplifier-storage ring design. One or two synchronized, counterpropagating laser pulses are injected into a regenerative amplifier cavity and amplified by gain media which are pumped repetitively by electrical or optical means. The gain media excitation pulses are tailored to efficiently amplify the laser pulses during each transit. After the laser pulses have been amplified to the desired intensity level, they are either switched out of the cavity by some switch means, as for example an electro-optical device, for any well known laser end uses, or a target means may be injected into the regenerative amplifier cavity in such a way as to intercept simultaneously the counterpropagating laser pulses. One such well known end uses to which this invention is intended is for production of high density and temperature plasmas suitable for generating neutrons, ions and x-rays and for studying matter heated by high intensity laser radiation.

HEAT TRANSFER AND FLUID FLOW

REFER ALSO TO CITATION(S) 30907, 31027

31070 Separation of flowing gas mixtures by thermal diffusion. Olander, D.R. (Univ. of California, Berkeley). *High Temp. Sci.;* 10: No. 4, 223-240(Dec 1978).

The problem of separation of the constituents of a binary gas mixture flowing through a zone of nonuniform temperature is treated in a mathematically rigorous fashion. One dimensional flow in the absence of turbulence is assumed. Analytical solutions to the flux equation containing ordinary molecular diffusion and thermal diffusion are presented for two basic temperture distributions, a monotonically increasing gas temperature and a symmetric temperature profile. Analytical solutions are possible only if the temperature and composition dependence of the coefficients in the flux equations are neglected, and if the dimensionless parameter characterizing thermal diffusion is much less than unity. Numerical solution of the flux equations without these two approximations verify the adequacy of the analytical calculations. The analytical solutions permit establishment of rules-of-thumb for determining the flow rate needed to render separation of the gas constituents by thermal diffusion negligible.

MATERIALS TESTING

REFER ALSO TO CITATION(S) 30931, 31028, 31030, 31031, 31043, 31047, 31058, 31059

31071 (BDX—613-2407) **Simultaneous measurement of multilayered composites. Milestone report.** Heckman, R.V. (Bendix Corp., Kansas City, MO (USA)). Jun 1980. Contract AC04-76DP00613. 43p. NTIS, PC A03/MF A01.

A theoretical treatment of the eddy current problem involving a two-layered conductor laminate is presented for a rectangular cross section coil, with experimental eddy current measurements indicating that a frequency of 1.5 MHz should be used to measure a 6.45 μm aluminum conductor, a 0.5 MHz frequency should be used to measure a 50.8 μm aluminum conductor, and a frequency of 30 MHz should be used to measure lift-off. The schematic and the basic design of a two-frequency microprocessor controlled eddy current system is also presented.

31072 (HEDL-SA—1913) **Spatial averaging algorithms for ultrasonic inspection of austenitic stainless steel welds.** Horn, J. E.; Cooper, C.S.; Michaels, T.E. (Hanford Engineering Development Lab., Richland, WA (USA)). 7 Apr 1980. Contract AC14-76FF02170. 13p. (CONF-800668—1). NTIS, PC A02/MF A01.

From 2. international symposium on ultrasonic materials characterization; Gaithersburg, MD, USA (4 Jun 1980).

Interpretation of ultrasonic inspection data from stainless steel welds is difficult because the signal-to-noise ratio is very low. The three main reasons for this are the granular structure of the weld, the high attenuation of stainless steel, and electronic noise. Averaging in time at the same position in space reduces electronic noise, but does not reduce ultrasonic noise from grain boundary scattering. Averaging wave-forms from different spatial positions helps reduce grain noise, but desired signals can destructively interfere if they shift in time. If the defect geometry is known, the ultrasonic waveforms can be shifted before averaging, ensuring signal reinforcement. The simplest geometry results in a linear time shift. An averaging algorithm has been developed which finds the optimum shift. This algorithm computes the averaged, or composite waveform as a function of the time shift. The optimum occurs when signals from a reflector become aligned in time, producing a large amplitude composite waveform. This algorithm works very well, but requires significant computer time and storage. This paper discusses this linear shift averaging algorithm, and considers an implementation using frequency domain techniques. Also, data from several weld defects are presented and analyzed.

SAFETY ENGINEERING

31073 (LBL—9900) **Fire growth experiments: toward a standard room fire test.** Williamson, R.B.; Fisher, F.L. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1980. Contract W-7405-ENG-48. 43p. (CONF-791048—7). NTIS, PC A03/MF A01.

From The Combustion Institute Western States Section meeting; Berkeley, CA, USA (15 Oct 1979).

The use of full-scale room fire experiments and the development of a standard room fire test are discussed. A series of room fire experiments with a gas burner ignition source, and gypsum wallboard, glass fiber insulation and plywood linings are described in detail. The results of the experiments are discussed in the context of a standard room fire test.

ELECTRONIC CIRCUITS AND DEVICES

31074 (BDX—613-2339) **Improvement of external lead bond and flexure strengths by comparing lead base materials.** Blazek, R.J.; Piper, W.A. (Bendix Corp., Kansas City, MO (USA)). Apr 1980. Contract AC04-76DP00613. 8p. (CONF-800410—4). NTIS, PC A02/MF A01.

From Electronic component conference; San Francisco, CA, USA (28 Apr 1980).

Four types of copper alloys used as external leads for hybrid microcircuits were tested and evaluated to determine which base material properties produced the most improved bond and flexure strengths as compared with a standard lead material. (LCL)

31075 (BDX—613-2393) **Thin film gold etchant formulation and rinse removal. Final report.** Raut, M.K. (Bendix Corp., Kansas City, MO (USA)). Jul 1980. Contract AC04-76DP00613. 39p. NTIS, PC A03/MF A01.

The chemistry of gold etchant solutions used in photolithography of thin film networks (TFNs) for hybrid microcircuits was reviewed. The formulation and operating limits were revised to ensure that the initial solution makeup is always within required values for iodine concentration and specific gravity and that the etchant will not be used for an extended period of time. Rinsing procedures for removal of the gold etchant from the TFNs were evaluated. Increasing the rinse time beyond 15 seconds in deionized water does not significantly improve the removal of iodine. Nitrogen bubble burst, increased temperature of the rinse water, methyl alcohol rinse, and potassium iodide solution prerinse were shown to be effective in improving the rinse removal of iodine. Production requirements for stripping time for wet photoresist were shown to be more than three times longer than necessary to ensure that the photoresist was completely removed.

31076 (BDX—613-2395) **Hybrid microcircuit via development. Final report.** Norwood, D.P. (Bendix Corp., Kansas City, MO (USA)). Jun 1980. Contract AC04-76DP00613. 29p. NTIS, PC A03/MF A01.

Manufacturing processes were developed for making holes in alumina substrates, metallizing substrates on both sides and through the holes (vias), dry film photolithographing 6-μm-thick gold to 127-μm line widths and spacings, determining via quality, and protecting vias during HMC assembly processes. The few problems encountered were solved, and via technology is now established as a reliable and repeatable production technology for hybrid microcircuits. Via resistance on product HMCs usually measures from 4 to 6 mΩ which is well below the 10 mΩ maximum limit.

31077 (UCID—18728) **Engineering Research Division report on reports: calendar year 1979.** Gardner, C.L.; Johnston, S.J. (eds.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). Mar 1980. Contract W-7405-ENG-48. 79p. NTIS, PC A05/MF A01.

A bibliography of publications of members of the Engineering Research Division of the Electronics Engineering Department is presented for 1979. Abstracts for 148 publications are included, along with author and keywork indexes. (RWR)

WASTE PROCESSING PLANTS AND EQUIPMENT

REFER ALSO TO CITATION(S) 30783, 30821, 30822, 30823, 30824, 30825, 30826, 30827, 30828, 30829, 30830, 30831, 30832, 30833

COMBUSTION SYSTEMS

REFER ALSO TO CITATION(S) 30162, 30163

31078 (ANL-CT—78-4) **Numerical modeling of fluidized-bed combustor.** Sha, W.T.; Soo, S.L. (Argonne National Lab., IL (USA)). Nov 1977. Contract W-31-109-ENG-38. 160p. NTIS, PC A08/MF A01.

Optimum design of fluidized-bed combustor requires high carbon burn-up, good sulfur retention. minimized sorbent (Ca) utilization, efficient feed distribution and mechanical layout. These parameters are strongly affected by the dynamics of the fluidized bed. The dynamic behavior of fluidized combustor is formulated in terms of multidomain - multiphase mechanics. Fluidization, bubble mechanics, coal combustion, sorbent sulfation, oxidation, solids movement and elutriation, and heat transfer are explicitly taken into account in the proposed numerical model. The model solves conservation equations of mass, momentum and energy coupled with chemical reactions as boundary value problem in space and initial value problem in time. Multi-fluid model and modified implicit multi-field numerical scheme are employed. The objective of this numerical model is for use in engineering design and scaling. Progress to date shows that all necessary relations can be incorporated within the framework of an overall multidomain - multiphase model for deterministic computation. Provisions are made for subsequent refinements of submodels of individual mechanism and improvements of the existing numerical model. These refinements and improvements can be achieved as better understanding of physical phenomena and more experimental data become available. The numerical model outlined in this report is specifically designed for the fluidized-bed combustor; however, it can readily be extended to various coal gasification systems.

31079 (ANL/EES-TM—87, pp 105-128) **Measurements and interpretation of pressure and sound spectra of a pulse-combustion water heater.** Dhar, B.; Soedel, W.; Schoenhals, R.J. (Purdue Univ., Lafayette, IN). May 1980.

From Symposium on pulse combustion technology for heating applications; Argonne, IL, USA (29 Nov 1979).

Combustion pressures and noise levels of a single-chamber experimental pulse-combustion water heater of approximately 37 kW heating capacity were measured. A Fast Fourier Transform Analyzer was used to obtain pressure and sound spectra. These measurements are interpreted.

MARINE ENGINEERING

31080 **Subsea riser and flotation means therefor.** Taft, D.G.; Heilhecker, J.K. (to Exxon Production Research Co.). US Patent 4,176,986. 4 Dec 1979. Filed date 3 Nov 1977. 12p.

A marine drilling riser is provided with a plurality of buoyancy cans having fail safe dump valves operative to vent compressed gas from the buoyancy cans and thereby cause rapid loss of buoyancy. 6 figures.

PARTICLE ACCELERATORS

DESIGN, DEVELOPMENT, AND OPERATION

REFER ALSO TO CITATION(S) 31304

31081 **History of the ZGS (Argonne, 1979).** Day, J.S.; Krisch, A.D.; Ratner, L.G. (eds.). New York, NY; American Institute of Physics (1980). 463p. (CONF-7909111—).

From Symposium on the history of the ZGS; Argonne, IL, USA (13 Sep 1979).

Individual papers were abstracted separately for the data base.

BEAM DYNAMICS, FIELD CALCULATIONS, AND ION OPTICS

31082 (UCID—18732) **Beam deflection into a quadrant by a positionally stationary magnetic bending system.** Paul, A.C.; Neil, V.K. (California Univ., Livermore (USA). Lawrence Livermore National Lab.). 20 Jun 1980. Contract W-7405-ENG-48. 52p. NTIS, PC A04/MF A01.

A system of postionally stationary magnets is analyzed for the continuously variable deflection of a 50 MeV electron beam. The system is composed of a collection of horizontal and vertical bending magnets, quadrupoles, and a final deflection magnet that is conical in shape and capable of deflections of plus or minus 50 degrees simultaneously in both horizonal and vertical planes. Throughout the system the beam is assumed to be focused by its own magnetic self-field, the electric self-field being neutralized by background ions. The motion of the beam in the externally applied magnetic fields may then be considered as single particle motion. The system of bending magnets and quadrupoles pre-conditions the beam by introducing the proper displacements and angles at the entrance to the final deflection magnet for momentum deviations up to plus or minus one percent. The displacements and angles are determined by the chromaticity of the final deflection and are a function of the bending angles in the two planes. The total system is then doubly achromatic in both planes. The preconditioning magnets are of standard accelerator beam transport design while the conical deflection magnet is of a design fashioned from a television deflection coil scaled up by about a factor of 10 in size.

AUXILIARIES AND COMPONENTS

EXPERIMENTAL FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 31107

31083 (PUB—300(Vol.5)(No.1)) **Research/Accelerators. Bimonthly status report of operations, January-February 1980.** Knight, J.W. (ed.). (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 1980. Contract W-7405-ENG-48. 50p. NTIS, PC A03/MF A01.

Operations during January and February 1980 are summarized. Topics covered include publications and presentations; accelerator operations; and a research program summary for the Bevatron/Bevalac, 88-inch cyclotron, and 184-inch cyclotron. Progress on the PEP storage rings is described, and news is given of the Bevalac user's meeting, the Nuclear Science Program Advisory Committee meeting proposal deadline, and the new HILAC distribution magnet. (GHT)

31084 **Monitor update: 1979.** Grisham, D.L.; Ekberg, E.L.; Lambert, J.E.; Meyer, R.E.; Stroik, P.J.; Wickham, M.D. (Los

Alamos Scientific Lab., NM). pp 268-269 of Proceedings of the 27th conference on remote systems technology. Wallin, D.R. (ed.). La Grange Park, IL; American Nuclear Society Inc. (1980).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

The Clinton P. Anderson Meson Physics Facility (LAMPF) has developed an advanced remote-handling system (Monitor) that is routinely used to perform complex tasks required to maintain, replace, and improve highly radioactive experimental facilities and components. This advanced system is based on the use of first-generation, force-reflecting servomanipulators that are placed at the remote-task site by a commercial hydraulic crane. A number of television cameras provide the viewing for the operations. Although LAMPF is now able to perform all the maintenance necessary on our main experimental beam line, advancements in manipulator dexterity and capacity, television viewing, and master-slave control links are required to develop the speed and dexterity necessary for general use. These developments should be undertaken as soon as possible to provide a means of routine handling of toxic and dangerous materials, as well as a capability to respond to disasters.

31085 **Use of smaller cyclotrons (20- to 40-MeV protons) for the reliable production of large quantities of shorter lived (13 h-3 days) radioisotopes for incorporation into in vivo radiodiagnostic drugs.** Fleischer, A.A. (Medi-Physics, Inc., Emeryville, CA). *Trans. Am. Nucl. Soc.;* **33**: 222(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31086 **Accelerator preparation of radioisotopes for medical applications.** O'Brien, H.A. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* **33**: 222-224(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

INSTRUMENTATION

RADIATION INSTRUMENTATION

GENERAL DETECTORS AND MONITORS

REFER ALSO TO CITATION(S) 30849

31087 (COO—3130-3) **New neutrino detector at B.N.L.** Lanou, R.E. (Brown Univ., Providence, RI (USA)). 1979. Contract AC02-76ER03130. 4p. (CONF-790365—11). NTIS, PC A02/MF A01.

From 16. rencontre de moriond; Les Arcs, Savoie, France (17 Mar 1979).

A neutrino detector is being built which will have good discrimination between single electrons and gamma ray conversion, good angular resolution on individual tracks, good discrimination between pions and protons, and the ability to distinguish extra, low energy tracks at the vertex, neutrons and gamma rays in an event, and events with a decaying muon. (FS)

31088 (HEDL-SA—2059) **Solid State Track Recorder applications in United States nuclear reactor energy programs.** Gold, R.; Ruddy, F.H.; Roberts, J.H. (Hanford Engineering Development Lab., Richland, WA (USA)). Jan 1980. Contract AC14-76FF02170. 8p. (CONF-800607—75). NTIS, PC A02/MF A01.

From American Nuclear Society annual meeting; Las Vegas, NV, USA (8 Jun 1980).

The domain of Solid State Track Recorder (SSTR) applications in United States nuclear reactor energy programs extends from the harsh high temperature environments found in high power reactor cores to very low flux environments arising in out-of-core locations, critical assemblies, or away from reactors (AFR) experiments. The neutron energy region arising in these applications is very broad, covering more than eight orders of magnitude from thermal up to fusion energies. The range of neutron flux/fluence intensity is even greater, extending over more than thirteen orders of magnitude. As a consequence, use of a variety of SSTR is entailed in US nuclear reactor energy programs.

31089 (LA-UR—80-1209) **Tritium monitoring system using a modified Kanne chamber for use in tritium contaminating environments.** Anderson, D.F.; Hiebert, R.D. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 13p. (CONF-800427—5). NTIS, PC A02/MF A01.

From Tritium technology in fission, fusion, and isotopic applications; Dayton, OH, USA (29 Apr 1980).

A Kanne chamber has been redesigned to reduce its sensitivity to such contaminants as tritium water vapor and tritiated oil. The high voltage electrode has been replaced by a wire cylinder and the collection electrode has been reduced in diameter. The sensitivity to contamination of the chamber has been reduced by about a factor of 40. The design allows for decontamination of the chamber in place. The improved electronics used is also discussed.

RADIATION DOSEMETERS

REFER ALSO TO CITATION(S) 30991

31090 (DOE/ET/37239—1) **Energy dependence of metallic-encapsulated thermoluminescent dosimeters. Annual report.** Simons, G.G. (Kansas State Univ., Manhattan (USA). Dept. of Nuclear Engineering). Jun 1980. Contract AS02-78ET37239. 83p. NTIS, PC A05/MF A01.

The gamma-ray energy responses of encapsulated ^{7}LiF and CaF_2:Mn thermoluminescent dosimeters were measured and compred to calculated values. This study was performed in order to improve the accuracy of gamma-ray heating measurements made in polyenergetic gamma-ray fields such as Argonne National Laboratory's Zero Power Reactors. Equations used in the development of the TERC/III computer code and code input parameters are specified. A section on TLD precision is also included. Comparisons between calculations and experiments are reported for a gamma-ray energy range of 0.122 to 1.33 MeV and encasement media with a range of atomic numbers from 13 to 82.

31091 (DOE/NV/00410—T1) **Beta calibration system for film dosimeters.** Orcutt, J.A. (San Diego State Univ., CA (USA)). 1980. Contract AC08-76NV00410. 53p. NTIS, PC A04/MF A01.

Thesis.

The development of a beta calibration system for film dosimeters is described. A variable-cavity extrapolation chamber was used to measure the beta dose-rate at a position to be used for film exposures. The operation of an extrapolation chamber is based on the Bragg-Gray cavity theory. This theory stipulates that the amount of ionization produced in a small, gas-filled cavity is representative of the ionization produced in the surrounding medium provided that the beta flux is not disturbed by the presence of the cavity. The extrapolation chamber is used to make measurements which may be extrapolated to represent a vanishingly small cavity. The limiting scope of the linear relationship between chamber output current and chamber electrode spacing is expressed in amp/cm. The limiting slope (amp/cm) may be manipulated through the application of conversion factors and expressed as a radiation dose-rate (rad/h).

NUCLEAR SPECTROSCOPIC INSTRUMENTATION

31092 (UCRL—52953) **Large-scale automation of the Lawrence Livermore Laboratory x-ray analytical facilities.** Wallace, P.L.; Shimamoto, F.Y.; Quick, T.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 29 May 1980. Contract W-7405-ENG-48. 16p. NTIS, PC A02/MF A01.

Lawrence Livermore Laboratory (LLL) has undertaken an ambitious plan to automate its x-ray analytical equipment. This project ultimately will automate 15 x-ray diffraction and 3 x-ray spectrometric systems. All automation is being done by retrofitting existing equipment and combining it with minicomputers to produce smart instruments. Two types of smart instruments have been developed: one that controls an experiment and acquires data and another that analyzes data and communicates with LLL's large computer center. Three of the former type have been built and are operating; seven more will soon be put into service. Only two of the later type are needed, and both are currently in service. We describe the details of our overall plan, the smart instruments, the retrofitting, our current status, and our software.

HIGH ENERGY PHYSICS INSTRUMENTATION

REFER ALSO TO CITATION(S) 30849, 31272

31093 (COO—3071-246) **Criterion for avoiding hot spots in calorimeters.** Selove, W. (Pennsylvania Univ., Philadelphia (USA)). 20 May 1980. Contract AC02-76ER03071. 6p. NTIS, PC A02/MF A01.

Simple energy loss conditions which must be satisfied to avoid hot spots in a calorimeter are described. (FS)

RADIOMETRIC INSTRUMENTS

31094 **Suitability of x-ray paper as an inspection tool for flat-plate nuclear fuel.** Barna, B.A. (EG and G Idaho, Inc., Idaho Falls). *Trans. Am. Nucl. Soc.;* **33**: 774(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

RADIATION EFFECTS ON INSTRUMENT COMPONENTS, INSTRUMENTS, OR ELECTRONIC SYSTEMS

REFER ALSO TO CITATION(S) 31088

MISCELLANEOUS INSTRUMENTS

REFER ALSO TO CITATION(S) 30065, 30202, 30212, 30215, 30317, 30793, 30854, 30858, 30911, 30933, 30957, 30971, 31014, 31092

31095 (BDX—613-2430) **Automation of a guarded hot plate thermal conductivity instrument.** Holland, L.L. (Bendix Corp., Kansas City, MO (USA)). Jun 1980. Contract AC04-76DP00613. 98p. NTIS, PC A05/MF A01.

The Thermo-Physics Corporation's GP-1800 guarded hot plate thermal conductivity instrument has been automated using a Digital Equipment Corporation PDP 11/35 minicomputer with an Industrial Control Subsystem Remote. Automation included constructing a hardware link between the instrument and the minicomputer system and designing, writing, and documenting software to perform equipment control, data acquisition, data reduction, and report generation. The software was designed and written so that non-programmers can run the thermal conductivity experiment.

31096 (LA—8236) **FPS-vidicon television camras for ultrafast-scan data acquisition.** Noel, B.W.; Yates, G.J. (Los Alamos Scientific Lab., NM (USA)). Jun 1980. Contract W-7405-ENG-36. 32p. NTIS, PC A03/MF A01.

Two ultrafast-scan (<8 ms/field) television (TV) camera prototypes have been developed for closed-circuit data-acquisition applications. The line and field rates are quasi-continuously adjustable. The number of lines, the integration duty cycle, and the scan direction are among the other adjustable parameters. Typical resolution at the fastest scan rate is >500 TV lines per picture height with a corresponding dynamic range (to light input) of more than 100. The cameras use the unique properties of FPS vidicons and specially designed electronics to achieve their performance levels and versatility. The advantages and disadvantages of FPS vidicons and of antimony trisulfide and silicon target materials in such applications are discussed in detail. All of the electronics circuits are discussed. The sweep generator designs are treated at length because they are the key to the cameras' versatility. Emphasis is placed on remotely controllable analog and digital sweep generators. The latter is a complete CAMAC-compatible subsystem containing a 16-function master arithmetic logic unit. Pulsed and cw methods of obtaining transfer characteristics are described and compared. The effects of generation rates, tube types, and target types on the resolution, determined from contrast-transfer-function curves, are discussed. Several applications are described, including neutron TV pinhole, TREAT, and barium-release experiments.

31097 (LBL—10992) **Optical multichannel analyzer techniques for high resolution optical spectroscopy.** Chao, J.L. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1980. Contract W-7405-ENG-48. 100p. NTIS, PC A05/MF A01.

Thesis.

The development of optical multichannel analyzer techniques for UV/VIS spectroscopy is presented. The research focuses on the development of spectroscopic techniques for measuring high resolution spectral lineshape functions from the exciton phosphorescence in H_2-1,2,4,5-tetrachlorobenzene. It is found that the temperature dependent frequency shifts and widths confirm a theoretical model based on an exchange theory. The exchange of low energy phonon modes which couple with excited state exciton transitions is shown to display the proper temperature dependent behavior. In addition to the techniques for using the optical multichannel analyzer (OMA) to perform low light level target integration, the use of the OMA for capturing spectral information in transient pulsed laser applications is discussed. An OMP data acquisition system developed for real-time signal processng is described. Both hardware and software interfacing considerations for control and data acquisition by a microcomputer are described. The OMA detector is described in terms of the principles behind its photoelectron detection capabilities and its design is compared with other optoelectronic devices.

31098 (SAND—80-0975) **Microbalance apparatus for measuring moisture absorption and desorption.** Boultinghouse, K.D. (Sandia National Labs., Albuquerque, NM (USA)). Jun 1980. Contract AC04-76DP00789. 17p. NTIS, PC A02/MF A01.

An apparatus for measuring water absorption and desorption and environmental test condition over a saturated aqueous salt solution is described. The apparatus consists of a vacuum gravimetric microbalance and associated instrumentation. The apparatus can accommodate a specimen size of 2.54 cm x 2.54 cm x 10.16 cm and weight of 100 gm. The balance will respond to mass changes from near vacuum to positive pressure of 2 atmospheres. The maximum operating temperature of the system is 125°C. As water is absorbed or desorbed by the specimen, the mass change and environmental data (temperature, pressure and dew point) are continuously collected in digital form. Desorption of the test specimen is performed under full vacuum; data from both tests can then be manipulated in a variety of ways and plotted. To demonstrate the utility of the apparatus, test procedures and data from the system are presented. Multiple tests measuring moisture diffusion in an epoxy resin casting (Ferro CE-9000) indicate that the system is capable of accurately measuring rates of diffusion as low as 8.18×10^{-10} cm²/s. The principal advantages of this apparatus are continuous recording of moisture mass change versus time, sensitivity of mass measurement, a continuously monitored test environment and the ability to study both absorption and desorption of the test material without its removal from the test environment.

31099 (UCRL—52532(Vol.1)) **Computer automation of continuous-flow analyzers for trace constituents in water. Volume 1. Operator instructions.** Crawford, R.W.; Stephens, F.B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 4 Apr 1979. Contract W-7405-ENG-48. 62p. NTIS, PC A04/MF A01.

This document has been written as an aid to an operator when running continuous flow analyses using the LLL programs. It refers specifically to the Technicon AutoAnalyzer instrument. The system, hardware and software, is described so that the operator can relate to the sequence of operations. The importance of the arrangement of solutions in the automatic sampler is emphasized. All prompts and responses are discussed in detail, including editing features and the various options available. In addition, the output and line-printer programs are described along with special auxiliary programs to be used in troubleshooting.

31100 (Y—2214) **Mass spectrometer for the analyses of gases.** Ferguson, J.R.; Rogers, E.R. (Oak Ridge Y-12 Plant, TN (USA)). 30 Jun 1980. Contract W-7405-ENG-48. 16p. NTIS, PC A02/MF A01.

A 6-in-radius, 60° magnetic-sector mass spectrometer (designated as the MS-200) has been constructed for the quantitative and qualitative analyses of fixed gases and volatile organics in the concentration range from 1 ppM (by volume) to 100%. A partial pressure of 1×10^{-6} torr in the inlet expansion volume is required to achieve a useful signal at an electron-multiplier gain of 10,000.

31101 **High-speed operation of $LiNbO_3$ electro-optic interferometric waveguide modulators.** Leonberger, F.J. (Lincoln Laboratory, Massachusetts Institute of Technology, Lexington, Massachusetts 02173). *Opt. Lett.;* **6**: No. 7, 312-314(Jul 1980).

High-speed optical intensity modulation is reported for the first time using single-mode electro-optic interferometric waveguide modulators formed from Ti-diffused waveguides in $LiNbO_3$. For cw 0.633-μm optical inputs, modulation at rates up to 1.4 GHz has been achieved by driving the interferometer through multiple-π phase shifts. Envelope modulation of a 275-MHz optical pulse train from a cw mode-locked frequency-doubled Nd:YAG laser with a 68.9-MHz drive signal has also been demonstrated.

31102 (COO—4596-1(Vol.3)(App)(5-79)) **DART II documentation. Volume III. Appendices.** (Radian Corp., Austin, TX (USA)). 23 May 1979. Contract EY-77-C-02-4596. 368p. NTIS, PC A16/MF A01.

The DART II is a data acquisition system that can be used with air pollution monitoring equipment. This volume contains appendices that deal with the following topics: adjustment and calibration procedures (power supply adjustment procedure, ADC calibration procedure, analog multiplexer calibration procedure); mother board signature list; schematic diagrams; device specification sheets (microprocessor, asynchronous receiver/transmitter, analog-to-digital converter, arithmetic processing unit, 5-volt power supply, +- 15-volt power supply, 24-volt power supply, floppy disk formater/controller, random access static memory); ROM program listing; 6800 microprocessor instruction set, octal listing; and cable lists. (RR)

31103 **Automated ultrasonic scanning of flat-plate nuclear fuel.** Barna, B.A. (EG and G Idaho, Inc., Idaho Falls). *Trans. Am. Nucl. Soc.;* **33**: 774-775(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31104 **Eddy-current cladding integrity testing and data analysis, HFEF/N.** Franklin, E.M.; Phipps, R.D. (Argonne National Lab., Idaho Falls, ID). *Trans. Am. Nucl. Soc.;* **33**: 906-907(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31105 **Completely contained and remotely operated digital density meter.** Goergen, C.R. (E.I. duPonte de nemours and Co., Aiken, SC). *Trans. Am. Nucl. Soc.;* **33**: 909-910(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31106 Remote fatigue crack growth measurement system. Lowry, L.M.; Malik, H.J.; Perrin, J.S. (Battelle Columbus Labs., Columbus, OH). *Trans. Am. Nucl. Soc.;* **33**: 910-911(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31107 Monitor update, 1979. Grisham, D.L.; Ekberg, E.L.; Lambert, J.E.; Meyer, R.E.; Stroik, P.J.; Wickham, M.D. (Los Alamos Scientific Lab., NM). *Trans. Am. Nucl. Soc.;* **33**: 917-918(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

WELL LOGGING INSTRUMENTATION

REFER ALSO TO CITATION(S) 30237, 30561

EXPLOSIONS AND EXPLOSIVES

CHEMICAL

31108 (LA—8436-MS) **X-0298: a rubber-bonded PBX.** Benziger, T.M.; Loughran, E.D.; Davey, R.K. (Los Alamos Scientific Lab., NM (USA)). Jul 1980. Contract W-7405-ENG-36. 16p. NTIS, PC A02/MF A01.

The properties of X-0298, a rubber-bonded HMX composition, are described. It is a high explosive of exceptional stability, an effect of its novel binder system (a styrene-ethylenebutylene-styrene block copolymer extended with a paraffinic oil). It appears particularly suited for applications that require extended service at elevated temperatures.

31109 (MHSMP—80-32) **Accuracy and precision of analysis of phenoxy in TATB/phenoxy compositions.** Richardson, B.R. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, TX (USA)). Jul 1980. Contract AC04-76DP00487. 9p. NTIS, PC A02/MF A01.

A method for determining the phenoxy content of TATB/phenoxy formulations was applied in order to test the accuracy and precision of the procedure. The development of an optimum conditions variance control chart for this analysis is outlined and the results shown. The accuracy and precision of the method were found to be acceptable for certification of TATB/phenoxy lots.

EXPLOSION DETECTION

REFER ALSO TO CITATION(S) 31249

ENVIRONMENTAL SCIENCES, ATMOSPHERIC

BASIC STUDIES

REFER ALSO TO CITATION(S) 31139

31110 (DOE/EV/10040—1) **Role of temperate zone forests in the world carbon cycle: problem definition and research needs.** Armentano, T.V.; Hett, J. (eds.). (Institute of Ecology, Indianapolis, IN (USA)). 1979. Contract AC02-79EV10040. 77p. NTIS, PC A05/MF A01.

The proceedings of a workshop on carbon uptake and losses from temperate zone forests are presented. The goals of the workshop were to analyze existing data on growth and utilization of the temperate zone forest carbon pool and to identify further research needs in relation to the role of temperate forests in the global carbon cycle. Total standing stock and growth recovery transients were examined for most of the temperate region over a period from presettlement times to the present, with emphasis on the last three decades. Because of data availability, certain regions and topics were covered more in detail than others. Forest inventory data from most of the commercial timberlands of the north temperate zone suggest these forests have functioned over the past several decades as an annual sink for about 10^9 metric tons of carbon. Thus, net growth of these forests has withdrawn carbon from the atmosphere at a rate equivalent, approximately, to 50% of the annual rise in atmospheric carbon. Various data inadequacies make this estimate probably no more precise than plus or minus half of the value. Analysis of growth and vegetation changes in New England and the southeastern United States shows that forest biomass has partly recovered since extensive clearing took place in the 18th and 19th centuries. This regrowth represents a net withdrawal of carbon (carbon sink) from the atmosphere in recent decades, although the difference in pool size between present and original forests means that, in the longer term, the two regions have functioned as carbon sources.

31111 (DOE/EV/10097—1) **Global temperature patterns 6000 years ago. Progress report.** Webb, T. III. (Brown Univ., Providence, RI (USA)). 1980. Contract AC02-79EV10097. 41p. NTIS, PC A03/MF A01.

The overall goal is to illustrate the climatic patterns of 5000 to 7000 years ago over as wide an area of the northern hemisphere as possible. Mapping of the patterns in selected climatic variables at 5000 to 7000 years ago that can be reconstructed from pollen and marine-plankton data is planned. Multivariate statistical methods permit using the modern distribution of these data in order to transform their fossil remains into climate estimates of past times. Given these goals and methods, research during the first eight months focused on assembling the available modern and fossil data from each of the main areas under study. Two workshop conferences were held to help organize the joint work.

31112 (DOE/EV/10281—T1) **Global political system's perspective to climate-society interactions.** Schware, R. (Aspen Inst. for Humanistic Studies, Boulder, CO (USA)). 1980. Contract AC02-79EV10281. 23p. NTIS, PC A02/MF A01.

The purpose of this paper is to suggest some of the principal elements that might be useful in the development of a general theory of the climate-society interaction, to point out some of the pathways and linkages among political components involved in coping with climatic impacts, and to identify some obstacles, strategies, and incentives that apply to making policy choices related to climate.

31113 (LA-UR—80-2138) **Large scale meteorological influence during the Geysers 1979 field experiment.** Barr, S. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 15p. (CONF-800480—5). NTIS, PC A02/MF A01.

From ASCOT program planning meeting; Gettysburg, PA, USA (15 Apr 1980).

A series of meteorological field measurements conducted during July 1979 near Cobb Mountain in Northern California reveals evidence of several scales of atmospheric circulation consistent with the climatic pattern of the area. The scales of influence are reflected in the structure of wind and temperature in vertically stratified layers at a given observation site. Large scale synoptic gradient flow dominates the wind field above about twice the height of the topographic ridge. Below that there is a mixture of effects with evidence of a diurnal sea breeze influence and a sublayer of katabatic winds. The July observations demonstrate that weak migratory circulations in the large scale synoptic meteorological pattern have a significant influence on the day-to-day gradient winds and must be accounted for in planning meteorological programs including tracer experiments.

31114 (UCRL—84534) **Two-dimensional slope wind simulations in the finite element approximation.** Tuerpe, D.R. (California Univ., Livermore (USA). Lawrence Livermore National Lab.). Jun 1980. Contract W-7405-ENG-48. 17p. (CONF-800480—4). NTIS, PC A02/MF A01.

From ASCOT program planning meeting; Gettysburg, PA, USA (15 Apr 1980).

The hydrostatic fluid dynamics model developed at LLL has been used to simulate the development of katabatic winds. This model solves the Navier-Stokes equations in the Boussinesq approximation by the finite element method. Preliminary results indicate that to obtain physically reasonable results one has to choose unequal diffusion parameters in the horizontal (K/sub x/) and vertical (K/sub z/). The maximum velocities obtained with K/sub z/ = 1 m^2/sec and K/sub x/ = 100 m^2/sec are of the order of 2.5 m/sec for a slope of .2. Profiles of the downslope velocities will be presented at different points in the flow. As expected, the magnitude of the vertical diffusion coefficient K/sub z/ controls the depth of the flow which seems to increase only slightly with downhill distance, and the magnitude of the flow increases with cooling rate and slope.

31115 Expanded use of fossil fuels by the U.S. and the global carbon dioxide problem. Emanuel, W.R.; Olson, J.S.; Killough, G.G. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *J. Environ. Manage.;* **10**: No. 1, 37-49(Jan 1980).

Continued combustion of fossil fuels contributes to a steady increase of carbon dioxide concentration in the atmosphere. Projecting present increases in rates of fossil-fuel utilization, a doubling of CO_2 concentration in the atmosphere may be expected within the next 75 years. Based on preliminary calculations, coal utilization by the U.S. to the year 2020 accounts for between 9 and 14% of the increase in CO_2 concentration. Carbon dioxide in the atmosphere absorbs infrared radiation, causing an increase in the surface tem-

perature of the earth. The most recent climatic models indicate that each doubling in atmospheric CO_2 concentration will result in a temperature increase of approximately 3 +- 1°C, depending on the model used. Changes in average rates of precipitation and evaporation may follow, leading to higher probabilities of drought in the mid-latitudes (including the (U.S.). Manabe and Wetherald (J. Atmos. Sci., 32: 3-15 (1975)) have estimated the temperature increase at high latitudes to be three times the increase in the global average surface temperature. Large-scale melting of the polar ice caps and a subsequent increase in the surface area of the oceans may follow on a timetable that is not yet clear. The distribution of vegetation and agricultural activities can be expected to change in response to the temperature increase and associated with the analysis of the CO_2/climate problem mandate the initiation of an immediate global-scale interdisciplinary research effort to determine more clearly the components and connections of the problem and to develop strategies for reducing the impacts, i.e., contingency plans that could be helpful regardless of impact details which remain to be determined. 26 references.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 30196, 30202, 31102, 31158, 31167, 31239

31116 (ANL/ES—90) **Ecological and biomedical effects of effluents from near-term electric vehicle storage battery cycles.** (Argonne National Lab., IL (USA)). May 1980. Contract W-31-109-ENG-38. 333p. NTIS, PC A15/MF A01.

An assessment of the ecological and biomedical effects due to commercialization of storage batteries for electric and hybrid vehicles is given. It deals only with the near-term batteries, namely Pb/acid, Ni/Zn, and Ni/Fe, but the complete battery cycle is considered, i.e., mining and milling of raw materials, manufacture of the batteries, cases and covers; use of the batteries in electric vehicles, including the charge-discharge cycles; recycling of spent batteries; and disposal of nonrecyclable components. The gaseous, liquid, and solid emissions from various phases of the battery cycle are identified. The effluent dispersal in the environment is modeled and ecological effects are assessed in terms of biogeochemical cycles. The metabolic and toxic responses by humans and laboratory animals to constituents of the effluents are discussed. Pertinent environmental and health regulations related to the battery industry are summarized and regulatory implications for large-scale storage battery commercialization are discussed. Each of the seven sections were abstracted and indexed individually for EDB/ERA. Additional information is presented in the seven appendixes entitled; growth rate scenario for lead/acid battery development; changes in battery composition during discharge; dispersion of stack and fugitive emissions from battery-related operations; methodology for estimating population exposure to total suspended particulates and SO_2 resulting from central power station emissions for the daily battery charging demand of 10,000 electric vehicles; determination of As air emissions from Zn smelting; health effects: research related to EV battery technologies. (JGB)

31117 (ANL/ES—90, pp 7-66) **Effluents from the state-of-the-art lead/acid battery cycle.** May 1980.

In Ecological and biomedical effects of effluents from near-term electric vehicle storage battery cycles.

The lead/acid battery cycle, from mining and milling of raw materials through recycling of scrap batteries and disposal of wastes, is described. Material flows and emissions for various phases of the total cycle are estimated for per megawatt hour of installed capacity and for a scenario of three million lead/acid electric vehicles on the road by the year 2000.

31118 (ANL/ES—90, pp 67-93) **Effluents from the nickel/zinc battery cycle.** May 1980.

In Ecological and biomedical effects of effluents from near-term electric vehicle storage battery cycles.

The Ni/Zn battery cycle, from mining and milling of the raw materials through recycling of the scrap batteries and disposal of wastes, is described. Material flows and emissions for various phases of the total cycle are estimated for per megawatt hour of installed capacity and for a scenario of 8 x 10^6 electric vehicles on the road by the year 2000.

31119 (ANL/ES—90, pp 94-113) **Effluents from the nickel/iron battery cycle.** May 1980.

In Ecological and biomedical effects of effluents from near-term electric vehicle storage battery cycles.

The Ni/Fe battery cycle from mining and milling of the raw materials through recycling of the scrap batteries and disposal of wastes has been described. Material flows and emissions for various phases of the total cycle have been estimated for per megawatt hour of installed capacity and for a scenario of 8 x 10^6 electric vehicles on the road by the year 2000.

31120 (ANL/ES—90, pp 114-129) **Dispersion of effluents.** May 1980.

In Ecological and biomedical effects of effluents from near-term electric vehicle storage battery cycles.

Generic dispersion analyses are given for battery-related emission sources identified in Sections 2 through 4. Dispersion data in terms of resulting environmental concentrations are summarized for the year 2000. The following scenario is used: with 40 EVs equivalent to 1 MWh in each case, 3 x 10^6 EVs with lead/acid batteries totaling 7.5 x 10^4 MWh, and 8 x 10^6 EVs with either Ni/Zn or Ni/Fe batteries totaling 2.0 x 10^5 MWh. The information presented serves as a data base for subsequent sections of this report.

31121 (CONF-791204—39) **Assessment of the atmospheric effects of a satellite power system.** Rote, D.M.; Brubaker, K.L.; Lee, J.; Valentino, A.R. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 30p. NTIS, PC A03/MF A01.

From 2. Miami international conference on alternative energy sources; Miami Beach, FL, USA (10 Dec 1979).

The satellite power system has been proposed as an alternative, renewable energy source for the early part of the next century. The present paper focuses on a pertinent reference system that has been the focal point of a Concept Development and Evaluation Program (CDEP). In addition, one aspect of the CDEP program, namely, the Atmospheric Effects Assessment, is detailed. Starting with the troposphere, potential atmospheric effects and the present understanding of them are summarized as a function of altitude. The main source of disturbance is described as the space transportation system, which would include a heavy lift launch vehicle (HLLV) approximately five times larger than the Saturn V rocket. To transport the necessary materials into space, HLLVs would have to be launched once or twice per day for thirty years. Essentially all levels of the atmosphere will be affected. However, as the altitude increases, the atmosphere becomes increasingly rarified, the possible degree of modification increases, and the state of our knowledge regarding such modifications decreases. Hence, the results presented here are, in most cases, only preliminary.

31122 (CONF-800334—17) **Environmental assessment of DOE transportation programs.** Bernard, M.J. III; Singh, M.K. (Argonne National Lab., IL (USA)). 1980. Contract W-31-109-ENG-38. 12p. NTIS, PC A02/MF A01.

From 2. DOE environmental control symposium; Reston, VA, USA (17 Mar 1980).

At the first DOE Environmental Control Symposium the process of environmental planning, assessment, research and control for the projects of the DOE Assistant Secretary for Conservation and Solar's (ASCS) Office of Transportation Programs (OTP) was presented. In the months since that symposium the process has been in continual use with a large measure of success. To illustrate how well it has worked, the treatment of electric vehicle battery off-gassing is presented here. Further, since most of the environmental activity has been directed toward producing Environmental Assessments (EA), the results of these EAs are also presented. This presentation begins with a short status report. It then illustrates the process by following EV battery off-gassing from its identification as a concern in an early EDP to research centering upon its resolution. The last portion of the paper focuses on the findings of the current EAs.

31123 (COO—1199-60) **Study of atmospheric pollution scavenging. Eighteenth progress report.** Semonin, R.G.; Bartlett, J.D.; Bowersox, V.C.; Gatz, D.F.; Naiman, D.Q.; Peden, M.E.; Stahlhut, R.K.; Stensland, G.J. (Illinois State Water Survey, Urbana (USA)). Jul 1980. Contract AS02-76EV01199. 102p. NTIS, PC A06/MF A01.

The analysis of aerosol samples obtained in rural east-central Illinois reveals a seasonal maximum in SO_4 during May to July and a similar pattern for NH_4. The annual median SO_4 is about 1 to 1.5 $\mu g/m^3$. In contrast to these ions, NO_3 displays highest values in the cold season. Soil-related species (Ca, K) seem to maximize in relation to farm tillage and harvesting practices. The NO_3 in recent precipitation samples over the northeast US increased between 1 and 2 times the values observed in the mid-1950's. A case study from SCORE-78 suggests that all ion concentrations analyzed from sequentially collected samples decreased from the onset of rain to a minimum corresponding to the heaviest rain rates. Four groups of elements in 10 event rain samples were identified using factor analysis. The groups include soluble and insoluble crustal elements, soluble pollutant metals and sulfate, and insoluble pollutant metals. Utilizing the factor analysis approach, the St. Louis METROMEX precipitation chemistry data showed that the SO_4 deposition patterns group consistently with those of other soluble pollutants. Additional factor analysis efforts on the St. Louis rainwater data set revealed that soluble and insoluble concentrations of a given element have different deposition patterns suggesting that scavenging and/or precipita-

tion formation processes dictate the patterns. An approach to managing the vast data base of rain chemistry used in the above studies is described. The software also examines the data for certain aspects of quality assurance. The procedures used to analyze ambient air filter samples are discussed.

31124 (DOE/EV/02874—59) **Misspecification of trend in spatial random-function interpolation with application to oxidant mapping. Technical report No. 28.** Faith, R.; Sheshinski, R. (Stanford Univ., CA (USA). Dept. of Statistics). Sep 1979. Contract EY-76-S-02-2874. 49p. NTIS, PC A03/MF A01.

In epidemiological studies of the effects of air pollution it is desirable to obtain estimates of the exposure to various pollutants of persons living throughout a geographical region under study. It is typically the case that pollution levels are measured at only a few locations. The problems of interpolating these values and of determining the accuracy of interpolation are amenable to analysis by way of spatial stochastic models. Such models can lead to an optimal interpolation technique, in a manner which is reviewed here. Estimators based on a correctly and incorrectly specified constant mean are compared with estimators based on an unspecified constant mean. The ratios of the mean squared errors (MSE) decreases with decreasing correlation between observations, and are very close to one. Estimation done with a specified linear trend function to estimation are compared with an unspecified linear trend function. For interpolation, the MSE's tend to be close except for high underlying correlation models. For extrapolation - the MSE values can be very different. A biased partially constrained estimator versus a fully constrained universally unbiased estimator in the presence of a linear trend is discussed. The biased and unbiased estimators have similar performance, except for very steep linear slopes of the trend. The comparisons of these sections are made in the context of rather special and perhaps unrealistic model assumptions. The Kriging method is used for interpolating (mapping) values of oxidant levels from 1973 at 16 stations located in the San Francisco Bay Area. Constant and linear trends are used for the purpose. The method requires knowledge of the spatial covariance structure of the pollutant to which it is applied. Some difficulties encountered in estimating this for oxidant levels in the San Francisco Bay Area are mentioned.

31125 (DOE/EV/04327—1) **Chemical composition of atmospheric precipitation in Minnesota and North Dakota. Final report, July 1, 1977-Jun 30, 1980.** (Minnesota Univ., Minneapolis (USA)). Jul 1980. Contract AS02-77EV04327. 31p. NTIS, PC A03/MF A01.

Precipitation chemistry in central North American appears to e controlled by interaction between soil-derived alkaline dust and gaseous NH_3 from the cultivated prairie and anthropogenic acid aerosols from the urban-industrial Lower Great Lakes-Ohio Valley region. Analyses of major ions and trace metals in precipitation event and snow core samples along a 600-km transect from the North Dakota prairie to the northeastern Minnesota forest indicate that loadings and concentrations of Ca^{++}, Mg^{++}, P/sub tot/, Al, Fe, M/sub n/, and other soil-derived material decrease with increasing distance from the prairie. Acidity is highest in the east and decreases to the west. Sulfate has natural sources in the west and anthropogenic sources in the east; its concentration was least at sites in the middle of the transect. Acidity increased and inputs of soil-derived elements decreased during winter when snow and freezing temperatures reduced alkaline influxes to the region. Atmospheric inputs of N and P may be beneficial to nutrient-poor ecosystems. However, precipitation in the eastern portions of the region which are highly sensitive to acid inputs, is approaching levels of acidity known to cause adverse effects. Any increase in acid loading will increase this danger.

31126 (EPRI-EA—1452) **Modeling of dry deposition of SO_2 and sulfate aerosols. Final report.** Lewellen, W.S.; Sheng, Y.P. (Aeronautical Research Associates of Princeton, Inc., NJ (USA)). Jul 1980. 87p. NTIS, PC A05/MF A01.

A model for dry deposition of SO_2 and sulfate aerosol is formulated, and calculations are made for four flow regimes; the outer boundary layer, the constant-flux region, within the vegetative canopy, and the viscous sublayer next to a smooth surface. The results of calculations are presented to demonstrate sensitivity of deposition to atmospheric stability, surface resistance, plant area density and structural shape, aerosol particle size, and Rossby number and canopy Reynolds number. A simple parameterized model for the SURE regional model is constructed.

31127 (NP—24453) **Concentration fluctuations in plumes. Environmental research monograph, 1979-4.** Netterville, D.D.J. (Syncrude Canada Ltd., Edmonton, Alberta). 1979. 228p. NTIS (US Sales Only), PC A11/MF A01.

The random fluctuation of concentration levels in a plume is studied using a wind tunnel simulation of dispersion in the neutrally stable atmospheric boundary layer. A fast response hot-film probe is developed and used to measure high frequency fluctuations of helium tracer concentration in the wind tunnel. Plume intermittency is well described by a Gaussian error function model originally developed for turbulence intermittency in round free jets. The classic reflected Gaussian model for mean concentrations successfully reproduces the spatial distribution of mean concentration in the elevated tracer plume. An expression for the mean field eddy diffusivity is obtained from the reflected Gaussian model, and compares favorably with experimentally-derived values. For non-uniform winds, the vertical eddy diffusivity has a complex variation with height above ground, becoming discontinuous near the source height.

31128 (UCID—18594) **User manual for SILVA: a computer code for estimating effects of pollution on the growth and succession of western coniferous forests.** Axelrod, M.C.; Kercher, J.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jul 1980. Contract W-7405-ENG-48. 81p. NTIS, PC A05/MF A01.

SILVA is a code developed for simulating impacts of SO_2 pollution on the growth and succession of western coniferous forests. It has been specifically parameterized for application to the ponderosa pine and mixed conifer forests of the Sierra Nevada, California. JABOWA, a code for simulating northeastern USA forests, was used as a framework for SILVA. The following elements are described: sample inputs; code structure; data, dynamic, control and internal variables; sample output, and considerations for setup at the user's computer installation. A listing is provided along with descriptions of all subroutines and functions.

31129 (UCID—18727) **Impact of new OH + HNO_3 rate measurement on models of atmospheric chemistry.** Wuebbles, D.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1980. Contract W-7405-ENG-48. 14p. NTIS, PC A02/MF A01.

Wine et al. found a new value for the rate of reaction of OH with HNO_3: $k = 1.52 +- 0.38 \times 10^{-14} \exp(649 +- 69)/T$. The impact of this new rate on atmospheric chemistry was studied assuming H_2O and NO_3 as the products. The change in total ozone expected from emissions of CF_2Cl_2 and $CFCl_3$ is reduced when the new rate is used. 4 figures, 1 table. (DLC)

31130 **Differential mortality and the environment: the challenge of multicollinearity in cross-sectional studies.** Lipfert, F.W. (Brookhaven National Lab., Upton, NY). *Energy Syst. Policy;* **3**: No. 4, 367-400(1980).

A review and analysis of cross-sectional studies of pollution effects on human mortality are presented and compared with existing studies. Some new results are presented for United States cities, counties, Standard Metropolitan Statistical Areas, and states. The results for total suspended particulates (TSP) are seen to be reasonably consistent, but wide disparities are noted in the results for suspended sulfates (SO_4). A detailed analysis of the work of Lave and Seskin (Air Pollution and Human Health, Johns Hopkins Univ. Press, 1978) shows that the differences between their results and those presented in this paper are due both to their faulty SO_4 data base and to multicollinearity effects, which are largely manifested in the sulfate variable. As a result, it is not possible to define precisely any mortality effects caused by sulfates. Recommendations are made for alternative methods of investigation. 23 references, 2 figures, 8 tables.

31131 **Comparison of an eulerian and a lagrangian time scale for over-water atmospheric flows during stable conditions.** Sethuraman, S.; Meyers, R.E.; Brown, R.M. (Brookhaven National Lab., Upton, NY). *Boundary-Layer Meteorol.;* **14**: 557-565(1978).

Lagrangian integral time scales were calculated from cross-wind concentration distributions of oil-fog smoke released from a continuous point source over the ocean during stable atmospheric conditions assuming an exponential correlation function. Variance of the lateral velocity fluctuations, σ^2/sub v/, and the energy dissipation rate, ϵ, were obtained from simultaneous Eulerian measurements at the beach. An Eulerian energy dissipation scale defined as σ^3/sub v//ϵ was then computed. The ratio of the Lagrangian integral scale to the Eulerian energy dissipation scale was found to be close to 1. This ratio was also estimated to be 1 based on physical and dimensional considerations regarding the cascade of energy. Length scales for longitudinal, lateral and vertical directions were interpreted with a model based on similarity considerations applicable for over-water atmospheric flows.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

31132 (EGG—1183-1755) **Aerial radiological survey of the area surrounding the Sequoyah Nuclear Power Plant, Daisy, Tennessee. Date of survey: November 1977.** Shipman, G.R.; Hendricks, T.J.; Frankhauser, W.A. (EG and G, Inc., Las Vegas, NV (USA). Energy Measurements Group). Dec 1979. Contract AC08-76NV01183. 13p. NTIS, PC A02/MF A01.

An airborne radiological survey of a 2000 km^2 area centered on the Sequoyah Nuclear Power Plant was conducted during the

period November 7-11, 1977. With two exceptions, detected radioisotopes and their associated gamma ray exposure rates were consistent with those expected from the normal background emitters. Aerial average exposure rates, given in μR/h at 1 m above the ground, are presented in the form of an isopleth map. Soil examples taken under selected flight lines showed reasonable agreement with the airborne data.

31133 (UCRL—50027-79) **Environmental monitoring at the Lawrence Livermore Laboratory. 1979 annual report.** Silver, W.J.; Lindeken, C.L.; White, J.H.; Buddemeir, R.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 25 Apr 1980. Contract W-7405-ENG-48. 75p. NTIS, PC A04/MF A01.

Information on monitoring activities is reported in two sections for EDB/ERA/INIS. The first section covers all information reported except Appendix D, which gives details of sampling and analytical procedures for environmental monitoring used at Lawrence Livermore Laboratory. A separate abstract was prepared for Appendix D. (JGB)

31134 (UCRL—50027-79, pp 1-20) **Environmental monitoring at the Lawrence Livermore Laboratory. 1979 Annual report.** 25 Apr 1980.

In Environmental monitoring at the Lawrence Livermore Laboratory. 1979 annual report.

In 1979, the annual average airborne gross beta activity in Livermore Valley air samples was 2.6 x 10^{-14} μCi/ml, or less than half the average observed in 1978. There were no atmospheric nuclear shots in 1979; therefore, fission products seen in the January air filters are probably a result of residual activity from the December 14, 1978 nuclear test in China. Airborne ^{238}U concentrations at Site 300 were higher than those at Livermore because of the depleted uranium used in high-explosive tests at the Site. However, these concentrations were well below the standards set by DOE. The average annual beryllium concentrations were less than 1% of the appropriate standard at both the Laboratory perimeter and Site 300. Water samples collected in the Livermore Valley and at Site 300 exhibit gross beta and tritium activities within the ranges previously observed in these areas. Tritium analyses were made on well-water-samples collected near the Livermore Water Reclamation Plant (LWRP). As was found during the 1977 and 1978 surveys, the highest tritium values were detected in wells west of the plant near Arroyo Las Positas; however all concentrations were well below the standards set by DOE. As a means of evaluating the possible impact of Laboratory effluents on locally grown foodstuff, the tritium content of Livermore Valley wines was compared with values from other California and European wines. The tritium levels in Livermore Valley wines were found to be within the range in both European wines and surface waters throughout the world and somewhat higher than those in California wines. Assessments of the calculated radiation dose to an individual from the environmental concentrations listed demonstrates that the dose contribution from Laboratory operations in 1979 was small compared with the dose received locally from natural sources.

31135 (UCRL—50027-79, pp D.2-D.19) **Sampling and analytical procedures for environmental monitoring at Lawrence Livermore Laboratory.** Lindeken, C.L.; Wong, K.M.; Seibel, G.L.; Griggs, K.S. 25 Apr 1980.

In Environmental monitoring at the Lawrence Livermore Laboratory. 1979 annual report.

Sample collection and analysis procedures employed in environmental monitoring at the Lawrence Livermore Laboratory are described. An integral part of the quality assurance program developed for environmental monitoring at Livermore, these procedures provide a basis for verifying that sampling and analytical activities are being performed as specified.

THERMAL EFFLUENTS MONITORING AND TRANSPORT

31136 Measurements of Lagrangian atmospheric dispersion statistics over open water. Sheih, C.M.; Frenzen, P.; Hart, R.L. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Appl. Meteorol.;* **19**: No. 5, 497-504(May 1980).

Atmospheric dispersion statistics in the Lagrangian frame have been evaluated over open water by using a double-theodolite system to track neutrally buoyant balloons released a few kilometers offshore during onshore winds. Analysis of the trajectories recorded in various atmospheric stabilities finds Lagrangian integral time scales corresponding to Pasquill stability categories C, D and E equal, respectively, to 9.0, 7.3 and 8.1 s for lateral dispersion and 2.3, 5.3 and 6.6 s for vertical dispersion. Normalized standard deviations of component velocity fluctuations (i.e., σ/sub upsilon//u/sub asterisk/ and σ/sub ω//u/sub asterisk/) for stability categories C, D and E are found to be 3.7, 1.8 and 2.4 for lateral motion and 2.2, 1.3 and 1.2 for vertical motion. Equivalent dispersion coefficients (σ/sub y/ and σ/sub z/) appropriate to flow over water are observed to undergo relatively less variation with stability than do those measured in flow over land. When compared to estimates derived from the Pasquill-Gifford curves for estimating dispersion over flat grassland, the dispersion coefficients over water are, in effect, shifted about two categories toward the stable side for the vertical component and between one and two categories toward the stable side for the lateral component.

31137 Lateral dispersion coefficients as functions of averaging time. Sheih, C.M. (Atmospheric Physics Section, Radiological and Environmental Research Division, Argonne National Laboratory, Argonne, Illinois 60439). *J. Appl. Meteorol.;* **19**: No. 5, 557-561(May 1980).

Plume dispersion coefficients are discussed in terms of single-particle and relative diffusion, and are investigated as functions of averaging time. To demonstrate the effects of averaging time on the relative importance of various dispersion processes, and observed lateral wind velocity spectrum is used to compute the lateral dispersion coefficients of total, single-particle and relative diffusion for various averaging times and plume travel times. The results indicate that for a 1 h averaging time the dispersion coefficient of a plume can be approximated by single-particle diffusion alone for travel times <250 s and by relative diffusion for longer travel times. Furthermore, it is shown that the power-law formula suggested by Turner for relating pollutant concentrations for other averaging times to the corresponding 15 min average is applicable to the present example only when the averaging time is less than 200 s and the tral time smaller than about 300 s. Since the turbulence spectrum used in the analysis is an observed one, it is hoped that the results could represent many conditions encountered in the atmosphere. However, as the results depend on the form of turbulence spectrum, the calculations are not for deriving a set of specific criteria but for demonstrating the need in discriminating various processes in studies of plume dispersion.

REGULATIONS

REFER ALSO TO CITATION(S) 30751

31138 (ANL/ES—90, pp 274-293) **Regulatory aspects.** May 1980.

In Ecological and biomedical effects of effluents from near-term electric vehicle storage battery cycles.

Existing regulatory actions and standards related to the near-term battery systems are reviewed, together with proposed standards and recommendations for anticipated constituents in the air emissions, water effluents, and solid wastes from battery-related operations. The likelihood of compliance with existing and proposed limitations assessed, and likely impedements to commercialization of the near-term batteries are discussed. In-plant occupational health and safety standards for metallic compounds contained in battery-cycle emissions are summarized.

ENVIRONMENTAL SCIENCES, TERRESTRIAL

BASIC STUDIES

31139 (DOE/EV/10040—2) **Role of organic soils in the world carbon cycle: problem definition and research needs.** Armentano, T.V. (ed.). (Institute of Ecology, Indianapolis, IN (USA)). 1979. Contract AC02-79EV10040. 43p. NTIS, PC A03/MF A01.

The following goals were addressed in the workshop: review and analysis of available data on carbon in organic soils from the past century to the present; assessment of the probable flux of carbon to and from organic soils in the near future; identification of major data inadequacies which preclude reliable analysis of the principal processes influencing carbon flux in organic soils; and proposal of research initiatives which could improve understanding of organic deposits in relation to the carbon cycle within a time frame of two to four years. The major finding of the workshop is that the organic soils are important in the overall carbon budget. Histosols and gleysols, the major organic soil deposits of the world, normally sequester organic carbon fixed by plants. They may now be releasing enough carbon to account for nearly 10% of the annual rise in atmospheric content of CO_2. Current annual release of carbon from organic soils is estimated to fall within the range of 0.03 to 0.37 x 10^9 t, a release equivalent to 1.3% to 16% of the annual increase of carbon in the atmosphere. Present annual releases of carbon from the Everglades Agricultural Area in Florida and the Sacramento-San Joaquin Valley in California are estimated at 0.017 x 10^9 tons.

Annual sequestering of carbon by undrained organic soils has been estimated at about 0.045 x 10^9 tons. Several strategies for peatland management are available, including creation, preservation, functional designation, and use of wetlands for agriculture and energy supply.

31140 (FWS/OBS—80/01) **Selected vertebrate endangered species of the seacoast of the United States.** (National Fish and Wildlife Lab., Washington, DC (USA)). Mar 1980. 580p. Fish and Wildlife Service, Washington, DC.

This series of species accounts provides resource managers and the public with information about Federally listed endangered and/or threatened vertebrate species that occur along, or within 100 kilometers of, the seacoast of the United States. Information about life history, distribution, requirements, and conservation of the subject species is included (range maps and other distributional data are not necessarily equivalent to critical habitat as defined in the Endangered Species Act of 1973, as amended). This series of accounts is intended to complement the computerized Sensitive Wildlife Information System (SWIS) developed by the US Army Corps of Engineers in coordination with the Offices of Endangered Species and Biological Services of the Fish and Wildlife Service.

31141 (LA—8050-NERP(Vol.1)) **Status of the flora of the Los Alamos National Environmental Research Park.** Foxx, T.S.; Tierney, G.D. (Los Alamos Scientific Lab., NM (USA)). May 1980. Contract W-7405-ENG-36. 58p. NTIS, PC A04/MF A01.

Under the Endangered Species Act of 1973, it became necessary to locate critical habitats of plant species in danger of extinction on State and Federal lands. In 1976 the Los Alamos National Environmental Research park (LA/NERP) was established to provide a study area that would contribute to the understanding of how man can best live in balance with nature while enjoying the benefits of technology. Under this mandate, a study to provide information regarding the locations of possible endangered, threatened, protected, and rare species within the LA/NERP was initiated in August 1977.

31142 **Simplified ethylene glycol monoethyl ether procedure for assessment of soil surface area.** Cihacek, L.J.; Bremner, J.M. *Soil Sci. Soc. Am. J.;* **43**: No. 4, 821-822(Jul 1979).

Studies with 33 soils selected to obtain a wide range in properties showed that the surface area values obtained by an ethylene glycol monoethyl ether (EGME) procedure that omitted the customary pretreatments to remove organic matter and saturate the soil sample with Ca^{2+} were similar to, and very highly significantly correlated with, the values obtained when these time-consuming pretreatments were included. The surface area values obtained by the simplified EGME procedure were very highly significantly correlated with the clay contents and cation-exchange capacities of the soils studied.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 31116, 31117, 31118, 31119, 31120, 31133, 31134, 31135, 31167, 31229

31143 (BNL—28141) **Temporal perspective on acid deposition research.** Hendrey, G.R. (Brookhaven National Lab., Upton, NY (USA)). 20 Feb 1980. Contract AC02-76CH00016. 14p. NTIS, PC A02/MF A01.

This statement presented to the Subcommittee on Natural Resources of the US House of Representatives gives a definition of acid rain, presents new data on the regional and temporal nature of the problem, and discusses research needs. (ACR)

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 31133, 31134, 31135

SOIL

REFER ALSO TO CITATION(S) 30322, 30326, 30403

31144 (EGG—2026) **Subsurface migration of radionuclides at the Radioactive Waste Management Complex: 1978.** Humphrey, T.G. (Idaho National Engineering Lab., Idaho Falls (USA)). Jul 1980. Contract AC07-76ID01570. 51p. NTIS, PC A04/MF A01.

This report describes the 1978 core drilling campaign at the Radioactive Waste Management Complex of the Idaho National Engineering Laboratory. The campaign is part of a continuing program to define radionuclide migration from buried waste. Samples of subsurface materials were collected from core drilled wells and from sample trenches excavated beneath buried waste. The sample materials were radiochemically analyzed and results are discussed. It is concluded that radionuclide migration is not now a hazard to the Snake River Plain aquifer.

31145 (EML—378) **Exposure rate conversion factors for radionuclides deposited on the ground.** Beck, H.L. (Department of Energy, New York (USA). Environmental Measurements Lab.). Jul 1980. 10p. NTIS, PC A02/MF A01.

Activity to exposure rate conversion factors are given for particulate gamma-emitting fission products and for a number of particulate activation products and residual nuclear materials which might be deposited on the ground as a result of weapons tests or other nuclear activities.

31146 (ORNL—5460) **Radiological survey of the inactive uranium-mill tailings at the Spook site, Converse County, Wyoming.** Haywood, F.F.; Christian, D.J.; Chou, K.D.; Ellis, B.S.; Lorenzo, D.; Shinpaugh, W.H. (Oak Ridge National Lab., TN (USA)). May 1980. Contract W-7405-ENG-26. 74p. NTIS, PC A04/MF A01.

Results of a radiological survey performed at the Spook site in Converse County, Wyoming, in June 1976, are presented. The mill at this site was located a short distance from the open-pit mine where the ore was obtained and where part of the tailings was dumped into the mine. Several piles of overburden or low-grade ore in the vicinity were included in the measurements of above-ground gamma exposure rate. The average exposure rate over these piles varied from 14 μR/hr, the average background exposure rate for the area, to 140 μR/hr. The average exposure rate for the tailings and former mill area was 220 μR/hr. Movement of tailings particles down dry washes was evident. The calculated concentration of ^{226}Ra in ten holes as a function of depth is presented graphically.

TERRESTRIAL ECOSYSTEMS AND FOOD CHAINS

31147 (EMSL-LV—0539-34) **Intake and digestibility of range plants grown on plutonium contaminated soils as determined with grazing cattle.** Bohman, V.R.; Blincoe, C. (Nevada Univ., Reno (USA); Environmental Protection Agency, Las Vegas, NV (USA)). Mar 1980. Contract AI08-76DP00539. 49p. NTIS, PC A03/MF A01.

Area 13 is one of several areas of the Nevada Test Site contaminated with transuranics. Cattle were grazed on the area to study the botanical and chemical composition of the forage, the digestibility of range plants as selected by range cattle, and the intake of plutonium and americium by grazing cattle. The botanical and chemical composition of the diet of cattle grazing on plutonium-contaminated range was determined. The major portion of the diet was browse plants which were high in fiber and ash but low in energy. Daily feed intake of the grazing animals was also determined so that the amount of nuclides ingested daily could be ascertained. Cattle generally consumed over 2 kilograms per 100 kilograms body weight of dry matter daily which resulted in a daily intake of 3600 to 6600 picocuries of plutonium-238, 85,000 to 400,000 picocuries of plutonium-239, and 11,000 to 31,000 picocuries of americium-241. The soil ingested by range cattle constituted the principal source of ingested plutonium and americium. This is not unexpected as plutonium oxide is one of the least soluble substances known and the range studied is one of very limited rainfall. As expected, the forage from an inner compound was contaminated to a greater extent than the range plants from an outer compound.

31148 (PNL—3315) **Environmental consequences of postulated plutonium releases from Exxon Nuclear MOFP, Richland, Washington, as a result of severe natural phenomena.** Jamison, J.D.; Watson, E.C. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Feb 1980. Contract AC06-76RL01830. 69p. NTIS, PC A04/MF A01.

Potential environmental consequences in terms of radiation dose to people are presented for postulated plutonium releases caused by severe natural phenomena at the Exxon Nuclear Company Mixed Oxide Fabrication Plant (MOFP), Richland, Washington. The severe natural phenomena considered are earthquakes, tornadoes, high straight-line winds, and floods. Maximum plutonium deposition values are given for significant locations around the site. All important potential exposure pathways are examined. The most likely 50-year committed dose equivalents are given for the maximum-exposed individual and the population within a 50-mile radius of the plant. The maximum plutonium deposition values most likely to occur offsite are also given.

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 30136, 30137, 30138, 30139, 30149, 30205, 30206, 30222, 30223, 30297, 30298, 30300, 30306, 30307, 30308, 30316, 30317, 30403

31149 (DOE/ORO—748(Rev.1)) **Oak Ridge reservation land-use plan.** (Department of Energy, Oak Ridge, TN (USA). Oak Ridge Operations Office). Mar 1980. 64p. NTIS, PC A04/MF A01.

This study establishes a basis for long-range land-use planning to accommodate both present and projected DOE program requirements in Oak Ridge. In addition to technological requirements, this land-use plan incorporates in-depth ecological concepts that recognize multiple uses of land as a viable option. Neither environmental research nor technological operations need to be mutually exclusive in all instances. Unique biological areas, as well as rare and endangered species, need to be protected, and human and environmental health and safety must be maintained. The plan is based on the concept that the primary use of DOE land resources must be to implement the overall DOE mission in Oak Ridge. This document, along with the base map and overlay maps, provides a reasonably detailed description of the DOE Oak Ridge land resources and of the current and potential uses of the land. A description of the land characteristics, including geomorphology, agricultural productivity and soils, water courses, vegetation, and terrestrial and aquatic animal habitats, is presented to serve as a resource document. Essentially all DOE land in the Oak Ridge area is being fully used for ongoing DOE programs or has been set aside as protected areas.

31150 **Effects of topsoil storage during surface mining on the viability of VA mycorrhiza.** Rives, C.S. (Illinois State Univ., Normal); Bajwa, M.I.; Liberta, A.E.; Miller, R.M. *Soil Sci.;* **129**: No. 4, 253-257(Apr 1980).

Storing topsoil for 3 years was shown to reduce substantially the levels of viable inocula relative to levels in adjacent, undisturbed prairie soils. The detrimental effect of storage on VA mycorrhiza is associated with the loss of viability of mycorrhizal fragments occurring in the stored soil. Data are also presented supporting an interaction between infected root segments and roots of uninfected plants as a major means of spreading mycorrhiza in these soils.

31151 **Cation exchange and selectivity in heated minerals.** Komarneni, S. *Soil Sci. Soc. Am. J.;* **43**: No. 4, 790-793(Jul 1979).

Various minerals that are commonly present in shales were heated in air as well as hydrothermally and their cation exchange capacity (CEC) and cation exchange selectivity (CES) values were determined. The CEC values of all the heated minerals decreased because of partial or complete collapse of the layers. The CES (KX/Ca/sub 1/2/X) values of montmorillonites and micaceous vermiculites increased because of wedge site formation by partial collapse after heat treatment to 500 and 750°C in air. The CES values of coarse grained micas, however, decreased by dry heat treatment because of the collapse of frayed edges or wedge zones. Heated illites randomly interstratified with montmorillonite behaved like the specimen montmorillonites, while heated, well crystallized illites behaved similarly to the coarse grained micas. That the wedge zones are enormously selective for potassium was clearly proven here by the collapsed, heated minerals. The CES values of poorly crystalline illites interstratified with montmorillonite increased while those of well crystallized illites with discrete vermiculite impurity decreased upon hydrothermal treatment at 400°C and 500 bar (pressure). The decrease or increase in CES of the hydrothermally heated illite minerals can be explained by the loss or creation respectively of wedge zones just as in the case of air-heated minerals.

REGULATIONS

REFER ALSO TO CITATION(S) 31138

ENVIRONMENTAL SCIENCES, AQUATIC

ENVIRONMENTAL SCIENCES, AQUATIC

BASIC STUDIES

REFER ALSO TO CITATION(S) 31110, 31140, 31252

31152 (BNL—27885) **Effect of advection on variations in zooplankton at a single location near Cabo Nazca, Peru.** Smith, S.L.; Brink, K.H.; Santander, H.; Cowles, T.J.; Huyer, A. (Brookhaven National Lab., Upton, NY (USA); Oregon State Univ., Corvallis (USA). School of Oceanography; Woods Hole Oceanographic Institution, MA (USA)). Apr 1980. Contract AC02-76CH00016. 36p. (CONF-800237—3). NTIS, PC A03/MF A01.

From International symposium on coastal upwelling; Los Angeles, CA, USA (4 Feb 1980).

Temporal variations in the biomass and species composition of zooplankton at a single midshelf station in an upwelling area off Peru can be explained to a large extent by onshore-offshore advection in the upper 20 m of the water column. During periods of strong or sustained near-surface onshore flow, peaks in biomass of zooplankton were observed at midshelf and typically oceanic species of copepod were collected. In periods of offshore flow at the surface, a copepod capable of migrating into oxygen-depleted layers deeper than 30 m was collected. A simple translocation model of advection applied to the cross-shelf distribution of Paracalanus parvus suggests that the fluctuations in P. pavus observed in the midshelf time-series were closely related to onshore-offshore flow in the upper 20 m. Fluctuations in abundance of the numerically dominant copepod, Acartia tonsa, were apparently affected by near surface flow also. The population age-structure suggests that A. tonsa was growing at maximal rates, due in part to its positive feeding response to the dinoflagellate/diatom assemblage of phytoplankton.

31153 (LA-UR—80-1516) **Groundwater: alternatives and solutions.** Roach, F. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 43p. (CONF-800137—1). NTIS, PC A03/MF A01.

From USDOE national workshop on ground water and energy; Albuquerque, NM, USA (29 Jan 1980).

Reasons for concern about water availability for the development of energy resources, especially in the Western USA, are reviewed. The use of ground water as a supplemental source, and eventually a major source of water for energy use is discussed. Examples of present use in the mining industry are given. Feasibility studies on the use of saline waters are discussed. The possibility of using water from deep aquifers fo energy source development is also considered. (JGB)

31154 (NP—24450) **Fisheries survey of the Beaver Creek Diversion System, 1978.** O'Neil, J.P. (Syncrude Canada Ltd., Edmonton, Alberta). Jun 1979. 89p. NTIS (US Sales Only), PC A05/MF A01.

On three occasions during the period May through October 1978, fish sampling was conducted in the Beaver Creek Diversion System. These efforts were oriented towards providing an inventory of post-diversion fish populations. The study was designed not only to update the existing data base, but to provide quantified and reproducible catch/unit effort data (CUE) which could effectively serve as a basis for future monitoring of fish populations. Sampling gear employed in the study included gill nets, beach seine, and backpack electrofisher. While the total of 11 species were encountered in the study area, only 6 were recorded in the upper diversion system (i.e., upstream of the Poplar Creek dam). Included in this latter group were two species of catostomids (white sucker, longnose sucker), the fathead minnow, brook stickleback, lake chub and spoonhead sculpin (Upper Beaver Creek only). Species collected in Poplar Creek, additional to those recorded in the upper diversion system, were Arctic grayling, northern pike, yellow perch, burbot and trout-perch. The spoonhead sculpin was not collected in Poplar Creek. Pertinent life history information was collected for each of the species in the study area and subsequently analyzed by computer. This material is provided in a separate data volume. Because of the significance of the white sucker in the diversion system, life history data for this species are presented in this report.

31155 (ORNL/TM—7242) **State water-use and socioeconomic data related to the second national water assessment.** Shepherd, A.D.; Hodgson, M.E.; Stewart, J.; Hake, K.A. (Oak Ridge National Lab., TN (USA)). Jul 1980. Contract W-7405-ENG-26. 164p. NTIS, PC A08/MF A01.

The previously reported Second National Water Assessment by the US Water Resources Council (WRC) contains considerable information relating to water withdrawal and consumption, based on data developed by the WRC and its member agencies for 106 hydrologically oriented Assessment Subregions (ASRs). The objective of this project was to convert the ASR data to state boundaries to make them more suitable for use in state and federal policy analysis. This report presents the converted Second Assessment projections of water-use and related socioeconomic data by state, rather than by ASR, and documents the data sources, conversion techniques, and assumptions.

31156 **Flax Pond ecosystem study: exchanges of inorganic nitrogen between an estuarine marsh and Long Island Sound.** Woodwell, G.M. (Ecosystems Center, Woods Hole, MA); Hall, C.A.S.; Whitney, D.E.; Houghton, R.A. *Ecology;* 60: No. 4, 695-702(Aug 1979).

The concentrations of inorganic nitrogen ions were measured in the tidal water flushing Flax Pond, an estuarine marsh on the north shore of Long Island, New York, USA. The basic sampling unit was one tidal cycle during which eight subsamples were taken, four on the flood and four on the ebb. The sampling was approximately weekly during 20 mo. Concentrations of the three forms of nitrogen (nitrate, nitrite, and ammonium) varied seasonally and with the periodic occurrence of algal blooms. Concentrations were highest in winter and lowest in spring and early summer, but details of

the patterns of abundance differed among the ions. There was a net discharge of nitrogen in the ammonium form from Flax Pond during summer and fall and a net input from the Sound in winter and spring. The net exchanges during 1 yr were zero for nitrite, an influx of nitrate of about 1 g N/m^2 to the marsh, and a release of about 2 g ammonium-N/m^2 into the Sound. The net total exchange was a release into Long Island Soud of approximately 1 g N/m^2 of marsh, an amount not statistically different from zero. Crude estimations of the total inorganic N-budget of Long Island Sound suggest that estuaries, precipitation, and rivers each contributed approximately equal inputs in earlier times.

31157 Evidence for deflection of the Gulf Stream at the Charleston rise. Pietrafesa, L.J. (North Carolina State Univ., Raleigh); Blanton, J.O.; Atkinson, L.P. *Gulfstream;* 4: No. 9, 1-4(1978).

It has long been known that the Gulf Stream meanders laterally along the whole of the South Atlantic Bight (the continental margin between Capes Canaveral and Hatteras), but a quasi-permanent deflection of the Gulf Stream has recently been postulated offshore of Charleston, South Carolina (Pashuk and Maul, 1973). This supposition is supported by hydrographic data, nutrient data and remotely sensed imagery of the sea surface topography.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 31116, 31117, 31118, 31119, 31120, 31123, 31143, 31167, 31229, 31250

31158 (BNL—27264) **Diffusion battery sampling of sulfuric acid aerosols formed in oleum spill experiments.** Tang, I.N.; Wong, W.T.; Munkelwitz, H.R. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract AC02-76CH00016. 18p. (CONF-800807—1). NTIS, PC A02/MF A01.

From AICHE symposium on developments in air pollution sampling and analysis; Seattle, WA, USA (10 Aug 1980).

Fuming sulfuric acid (oleum) is one of several hazardous chemicals routinely transported in bulk quantities on US waterways. In the event of a marine accident, a large amount of the cargo acid could suddenly be released into water, resulting in the formation of a dense sulfuric acid cloud. Experiments were carried out in the laboratory to study the factors controlling the extent of acid aerosol formation under conditions likely to occur in maritime spill accidents. A Sinclair-type diffusion battery was used for aerosol sizing. In this presentation, a brief discussion of an improved nonlinear iterative inversion method for the analysis of diffusion battery data is given. Experimental results obtained with monodisperse test aerosols and sulfuric acid aerosols formed during oleum spills are presented. It is shown that the diffusion battery, coupled with the inversion technique, is capable of sizing particles up to 0.8 μm in diameter.

31159 (ORNL—5521) **Transport and dispersion of pollutants in surface impoundments: a finite difference model.** Yeh, G.T. (Oak Ridge National Lab., TN (USA)). Jul 1980. Contract W-7405-ENG-26. 107p. NTIS, PC A06/MF A01.

A surface impoundment model by finite-difference (SIMFD) has been developed. SIMFD computes the flow rate, velocity field, and the concentration distribution of pollutants in surface impoundments with any number of islands located within the region of interest. Theoretical derivations and numerical algorithm are described in detail. Instructions for the application of SIMFD and listings of the FORTRAN IV source program are provided. Two sample problems are given to illustrate the application and validity of the model.

31160 (ORNL—5522) **Transport and dispersion of pollutants in surface impoundments: a finite element model.** Yeh, G.T. (Oak Ridge National Lab., TN (USA)). Jul 1980. Contract W-7405-ENG-26. 116p. NTIS, PC A06/MF A01.

A surface impoundment model in finite element (SIMFE) is presented to enable the simulation of flow circulations and pollutant transport and dispersion in natural or artificial lakes, reservoirs or ponds with any number of islands. This surface impoundment model consists of two sub-models: hydrodynamic and pollutant transport models. Both submodels are simulated by the finite element method. While the hydrodynamic model is solved by the standard Galerkin finite element scheme, the pollutant transport model can be solved by any of the twelve optional finite element schemes built in the program. Theoretical approximations and the numerical algorithm of SIMFE are described. Detail instruction of the application are given and listing of FORTRAN IV source program are provided. Two sample problems are given. One is for an idealized system with a known solution to show the accuracy and partial validation of the models. The other is applied to Prairie Island for a set of hypothetical input data, typifying a class of problems to which SIMFE may be applied.

31161 Draft environmental impact statement: proposed 1981 Outer Continental Shelf oil and gas lease sale No. 56. Volume 1 of 2. New Orleans, LA; Bureau of Land Management (1980). 401p. (NP—24983).

Proposed Outer Continental Shelf (OCS) Sale 56 is scheduled for August 1981 as the seventh sale of the new 5-Year Leasing Program. It would be the second OCS oil/gas lease sale held in the South Atlantic offshore region. The sale consists of 658,944 hectares (1,625,251 acres) offshore the states of North Carolina, South Carolina, Georgia, and Florida in 286 wildcat tracts located from 16 to 111 nautical miles from shore in water from 20 to 2100 feet deep. It is estimated that there are 1.4 billion barrels of oil and 2.5 trillion cubic feet of natural gas in the leasing area (conditional probability mean estimate); and that total development of these resources will require 101 exploratory wells, 56 production platforms, and 1299 development wells. Exploratory drilling is expected to take place over the 7 year period from 1982-1989 while platform installation and development drilling should be completed between 1988 and 1994. Production is expected to peak in 1993 with average daily production rates of 327 thousand barrels of oil and 62 million cubic of natural gas. Expected impacts from the proposed lease sale on environmental, social, and economic issues are presented. Four alternative courses of action, including holding the full sale, reducing the size and scope of sale, delaying sale, and withdrawal of sale, are discussed, and related environmental consequences are described. Information is presented under the following section headings: the proposal; alternatives including the proposed action; affected environment; environmental consequences; consultation and coordination; and appendices. Lists of preparers, references, and an index are also included. (JGB)

31162 Taurine and glycine in the gills of the clam Protothaca staminea exposed to chlorinated seawater. Roesijadi, G. (Marine Research Lab., Sequim, WA). *Bull. Environ. Contam. Toxicol.;* **22**: No. 4/5, 543-547(Jul 1979).

In the present study, individuals of the clam Protothaca staminea were exposed to chlorinated seawater for 26 days and the free amino acid levels of the gill tissue were measured. This experiment represents yet another condition of stress and a fourth bivalve species with respect to the available literature on the taurine:glycine ratio in stressed molluscs. Chlorine is commonly used as either a biocide or disinfectant in coastally located electric power plants or domestic waste treatment systems, respectively, and has been reported to adversley impact marine organisms.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 31133, 31134, 31135

WATER

REFER ALSO TO CITATION(S) 30322

AQUATIC ECOSYSTEMS AND FOOD CHAINS

31163 (COO—3573-30) **Fate of nuclides in natural water systems. Annual progress report, October 1, 1979-September 30, 1980.** Turekian, K.K. (Yale Univ., New Haven, CT (USA). Dept. of Geology and Geophysics). 30 May 1980. Contract AS02-76EV13573. 5p. NTIS, PC A02/MF A01.

Progress for the period October 1979 through September 1980 is reported on research aimed at understanding the fate of radionuclides in Long Island Sound. (ACR)

THERMAL EFFLUENTS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 31159, 31222

31164 (NYSERDA—79-8) **Manual for surface discharge thermal plume predictions.** Cataldo, J.C.; Goodman, A.S.; Gunawardana, V.K. (Cooper Union Research Foundation, Brooklyn, NY (USA)). Aug 1979. 59p. New York State Energy Research and Development Authority, Albany, NY.

The necessary procedures to predict subsurface isotherms of power plant thermal plumes are outlined. Thermal scanning measurements of surface temperatures are an intricate part of the procedure and may be obtained from infrared monitoring. The method presented is based upon a phenomenological model developed for the prediction of far field subsurface temperatures from a given set of surface isotherms. The model accuracy was verified at eight

different thermal power plants. The average difference between the predicted temperature and measured temperature was less than 0.2°C. Discharge and receiving water conditions considered were: surface and subsurface discharges; shallow lake and deep estuarine environments; and zero, mild, and strong currents parallel to shore. Important aspects of thermal pollution due to heated effluent discharging into lakes, estuaries, and ocean environment are reviewed in section I. The main elements of the model and a step-by-step procedure to predict subsurface temperatures are given in section II. The subsurface temperatures may be predicted by using nomograms provided in the appendix. A series of examples using actual power plant sites and measured surface isotherms are given in section III. (ERB)

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 30226, 30229, 30313, 30314, 30315

31165 (CONF-800137—(Summ.)) **Ground water and energy.** (Harbridge House, Inc., Boston, MA (USA)). May 1980. Contract W-7405-ENG-36. 26p. NTIS, PC A03/MF A01.

From USDOE national workshop on ground water and energy; Albuquerque, NM, USA (29 Jan 1980).

In view of complex environmental/energy decisions, the Environmental Impacts Division of the Office of Technology Impacts develops analytical methods for conducting policy analyses supporting decision making. The methods development process often begins with a workshop of leading experts and specialists in the relevant disciplines and issue areas; workshop findings are subsequently utilized by OTI to form a more solid foundation for viable policies. The National Workshop on Ground Water and Energy Production was envisioned as a tool through which OTI could obtain insights, information, and methods (on environmental, economical, physical, political, legal, and social issues) to use in its analyses, models, and assessments. To accomplish this, the Workshop comprised both plenary sessions and individual working groups. The former provided opportunities for all participants to explore issues from a broad perspective, whereas the latter enabled participants to focus on the three following areas: ground water supply; conflicts and barriers to its use; and alternatives or solutions to the various issues. This report summarizes information and insights gained by the Office of Technology Impacts during the course of the Workshop. The Key Findings section summarizes the most important facts discovered during the Workshop. The three general topics that follow (Supply, Conflicts and Barriers, and Alternatives) are those described in the Core Issues statements. The statements are reflective of the recommendations and analyses prepared by the several working groups.

REGULATIONS

REFER ALSO TO CITATION(S) 31138, 31165

ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES

ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES

REFER ALSO TO CITATION(S) 30167

SOCIAL AND ECONOMIC STUDIES

REFER ALSO TO CITATION(S) 30308, 30749, 30750, 31112, 31166

ASSESSMENT OF ENERGY TECHNOLOGIES

REFER ALSO TO CITATION(S) 30752

31166 (P—102-79-013) **Constraints and opportunities for power plant siting: technical issues.** (California Energy Commission, Sacramento (USA)). Nov 1979. 344p. NTIS, PC A14/MF A01.

This paper examines four ways to find more environmentally acceptable power plant sites. First, the geographical interaction between environmental resources and power plants is examined. The results are presented as Least Difficult Siting Areas. Second, the major environmental controversies or issues facing siting proposals in regulatory cases are identified. The policy-oriented recommendations to resolve them are presented in this summary section. The more detailed issue recommendations are contained in the supporting Appendices. Third, a process to custom-tailor solutions for specific siting proposals is examined. The range of options for resolving issues, extracted from the Appendices, is presented, demonstrating the amount of flexibility available. Finally, siting strategies are proposed that are based on an integrated analysis of the environmental issues. Using the siting strategies in conjunction with the Least Difficult Siting Areas should increase the success rate of finding acceptable power plant sites.

ENVIRONMENTAL IMPACT STATEMENTS

31167 (DOE/EV—0087) **Synthetic fuels and the environment: an environmental and regulatory impacts analysis.** (Department of Energy, Washington, DC (USA). Office of Technology Impacts). Jun 1980. 652p. NTIS, PC A99/MF A01.

Since July 1979 when DOE/EV-0044 report Environmental Analysis of Synthetic Liquid fuels was published the synthetic fuels program proposals of the Administration have undergone significant modifications. The program year for which the development goal of 1.5 million barrels per day is to be reached has been changed from 1990 to 1995. The program plan is now proposed to have two stages to ensure, among other things, better environmental protection: an initial stage emphasizing applied research and development (R and D), including environmental research, followed by a second stage that would accelerate deployment of those synthetic fuel technologies then judged most ready for rapid deployment and economic operation within the environmental protection requirements. These program changes have significantly expanded the scope of technologies to be considered in this environmental analysis and have increased the likelihood that accelerated environmental R and D efforts will be successful in solving principal environmental and worker safety concerns for most technologies prior to the initiation of the second stage of the accelerated deployment plan. Information is presented under the following section headings: summary; study description; the technologies and their environmental concerns (including, coal liquefaction and gasification, oil shale production, biomass and urban waste conversion); regulatory and institutional analyses; and environmental impacts analysis (including air and water quality analyses, impacts of carbon dioxide and acid rain, water availability, solid and hazardous wastes, coal mining environmental impacts, transportation issues, community growth and change, and regional impacts). Additional information is presented in seventeen appendixes. (JGB)

BIOMEDICAL SCIENCES, BASIC STUDIES

BEHAVIORAL BIOLOGY

REFER ALSO TO CITATION(S) 31112

31168 **Roosting of passerines over open water at night.** Kirby, R.E. (Fish and Wildlife Service, Migratory Bird and Habitat Research Lab., Laurel, MD). *North American Bird Bander;* 3: No. 3, 104-105(1978).

Night observations on the roosting of various species of birds on emergent vegetation over open water is presented. The following species were recorded: Barn Swallow (Hirundo rustica), Cliff Swallow (Petrochelidonpyrrhonota), Tree Swallow (Iridoproene bicolor), Bank Swallow (Riparia riparia), Rough-winged Swallow (Stelgidopteryx ruficollis), Purple Martin (Progne subis), red-winged black bird (Agelaius phoeniceus), and Yellow-headed Black Bird (Xanthocephalus xanthocephalus). (ACR)

31169 (DOE/EV/01322—132) **Vertebrate behavior and ecology. Progress report, July 1, 1977-May 31, 1980.** Tester, J.R.; Siniff, D.B. (Minnesota Univ., Minneapolis (USA)). Jun 1980. Contract AS02-76EV01332. 324p. NTIS, PC A14/MF A01.

Engineering design and development concentrated on five aspects during the past year: (1) development of high power output transmitters for monitoring animals from greater distances; (2) improvement and updating of a sonic transmitting and receiving system for monitoring fish and marine mammals; (3) design and testing of corrosive links which permit a transmitter to release from an animal at a specified time; (4) development of high frequency transmitters; and (5) development and testing of time delay transmitters. Field efforts resulted in further information on activity patterns and movements of sea otters in California and Alaska and of walleye pike in experimental channels. Three manuscripts and two theses presented as part of this report describe these aspects in detail.

31170 (LBL—10323) **Standardization of age-adjusted mortality rates.** Selvin, S.; Sacks, S.T.; Merrill, D.W. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Feb 1980. Contract W-7405-ENG-48. 13p. NTIS, PC A02/MF A01.

Because age is a significant variable in the occurrence and frequency of human disease, any comparison of disease or mortality rates, to be useful, must be age-specific or age-adjusted. Age-specific comparisons are not always appropriate or possible, however. A common method of eliminating the influence of age in comparing mortality rates from one community to another is to employ statistical methods of age-adjustment. While a variety of methods will accomplish this task, most are weighted averages of the age-specific rates. Two widely used adjustment procedures are direct and indirect age-adjustment.

BIOCHEMISTRY

REFER ALSO TO CITATION(S) 30416, 30962, 31002, 31189, 31191, 31201

31171 (BNL—27860) **Role of π-cation radicals in the enzymatic cycles of peroxidases, catalases, and nitrite and sulfite reductases.** Hanson, L.K.; Chang, C.K.; Davis, M.S.; Fajer, J. (Brookhaven National Lab., Upton, NY (USA); Michigan State Univ., East Lansing (USA). Dept. of Chemistry). 1980. Contract AC02-76CH00016. 22p. (CONF-800490—1). NTIS, PC A02/MF A01.

From Symposium on interaction between iron and proteins in oxygen and electron transport; Airlie House, VA, USA (13 Apr 1980).

Charge iterative extended Hueckel calculations, and magnetic and optical results on porphyrins, chlorins, and isobacteriochlorins (1) suggest that the catalytic cycles of the enzymes horseradish peroxidase, catalase, Neurospora crassa catalase, and nitrite and sulfite reductases proceed via π-cation radicals of their prosthetic groups; (2) offer distinguishing features for the optical and magnetic spectra of these radicals, pertinent to their detection as enzymatic intermediates; (3) reconcile the seemingly contradictory optical and NMR data on Compounds I of horseradish peroxidase; and (4) predict that the axial ligation of the heme differs for horseradish peroxidase and catalase.

31172 (BNL—28027) **Report on picosecond studies of electron transfer in photosynthetic models.** Netzel, T.L.; Bucks, R.R.; Boxer, S.G.; Fujita, I. (Brookhaven National Lab., Upton, NY (USA); Stanford Univ., CA (USA). Dept. of Chemistry). 1980. Contract AC02-76CH00016. 5p. (CONF-800656—2). NTIS, PC A02/MF A01.

From Picosecond meeting; Falmouth, MA, USA (18 Jun 1980).

Considerable spectroscopic work on reaction centers 8RC) from photosynthetic bacteria and on photosystem I (PSI) particles from green plants has established that the initial photochemical step in these systems is the subnanosecond tranfer of an electron resulting in the creation of an oxidized donor and a reduced acceptor. For both of these systems the electron donor is a dimer. The acceptor for bacterial RC's is bacteriopheophytin, a metal-free bacteriochlorophyll. The acceptor for PSI is thought to be chlorophyll/sub a/. Dimeric and trimeric model molecules containing PChl/sub a/ were studied. However, rather than relying on chemical equilibria to join the potential electron donors and acceptors, we covalently attached all of the subunits to form a single large molecule. The distance was altered between the donor and acceptor subunits by using both 10 atom and 5 atom chains. Also, the effects of altering the relative orientation of the donor and acceptor were probed by contrasting the kinetics observed with added pyridine too those observed with added alcohol. The addition of pyridine prevents the dimer and trimer models from aggregating. However, the addition of alcohol causes intramolecular bonding of the model's subunits though R-OH bridges. Because the dielectric constant (ϵ) of the solvent directly affects the kinetics of electron transfer reactions, several solvents were used: toluene, CH_2Cl_2, and CH_3CN. Also, since a goal of this type of research is to correlate electrochemical, spectroscopic and structural information to predict the likelihood of electron transfer reactions, we varied the redox span of the potential photoproducts.

31173 (BNL—28040) **Autoxidation and cytotoxicity.** Borg, D.C.; Schaich, K.M.; Elmore, J.J. Jr. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract AC02-76CH00016. 14p. (CONF-800591—2). NTIS, PC A02/MF A01.

From International conference on oxygen and oxy-radicals in chemistry and biology; Austin, TX, USA (26 May 1980).

A comprehensive synthesis, or reaction schema, to relate autoxidations of non-lipid compounds to lipid chain peroxidation in vivo is presented. This is done in the context of cytotoxic autoxidation reactions, and it is concluded that hydroxyl radicals produced by iron-dependent Fenton reactions serve as both primary toxicants and as sources of secondary toxicants. The latter stem from lipid chain peroxidation initiated by the Fenton-derived hydroxyl radicals, which are visualized as the obligate coupling step linking enzyme-dependent and non-enzymic autoxidations to potentially toxic outcomes.

31174 (SRO—1015-T3) **Literature guide for plant tissue culture.** Sommer, H.E. (Georgia Univ., Athens (USA). School of Forest Resources). 1979. Contract EG-77-S-09-1015. 22p. NTIS, PC A02/MF A01.

This guide to plant tissue culture literature provides the investigator with references to aid in deciding if tissue culture methods are applicable to his problem and provides an introduction to the methods of plant tissue culture and the results obtained. Only a small portion of the literature is covered in this guide, and is not intended as a substitute for a literature search. For the purpose of this guide we have interpreted tissue culture to include cell, callus, organ, embryo, and protoplast culture. We have to include references useful for developmental biology, plant breeding, plant propagation, plant physiology and biochemistry.

31175 **Specific 1,25-dihydroxyvitamin D_3 binding macromolecule in chicken bone.** Mellon, W.S.; DeLuca, H.F. (Univ. of Wisconsin, Madison). Contract EY-76-S-02-1668. *J. Biol. Chem.;* **255**: No. 9, 4081-4086(10 May 1980).

Cytosol prepared from homogenates of bone from vitamin D_3-deficient chicks contains a 3.7 S macromolecule having high affinity and low capacity for 1,25-dihydroxyvitamin D_3. Employing 1,25-dihydroxy-[26,27-^{3}H]vitamin D_3 (160 Ci/mmol) an apparent K/ sub d/ has been calcuated to be 7.6×10^{-11} M while the association and dissociation rate constants for the binding process at 25°C were determined to be 9.5×10^8 $M^{-1}min^{-1}$ and 2.3×10^{-2} min^{-1}, respectively. A 5.5 S molecule is also present which binds 1,25-dihydroxyvitamin D_3 and 25-hydroxyvitamin D_3 but appears to prefer 25-hydroxyvitamin D_3 and is increased by the addition of chick serum to cytosol. The 3.7 S material is neither a serum contaminant nor a component of the 5.5 S molecular species and is likely of intracellular origin. Under low salt conditions the 3.7 S macromolecule migrates to 4.3 S and 5.5 S regions on sucrose gradients suggesting aggregation of the protein. Several vitamin D_3 metabolites are capable of specifically binding to the 3.7 S macromolecule. The relative order of potency for several analogs causing displacement of specifically bound 1,25-dihydroxy-[26,27-^{3}H]vitamin D_3 is: 1,25-dihydroxyvitamin D_3 > 1 α-hydroxyvitamin D_3 ≧ 25-hydroxyvitamin D_3 > 24(R),25-dihydroxyvitamin D_3. It is concluded that chick bone cytosol contains a macromolecule of high affinity and low capacity for 1,25-dihydroxyvitamin D_3 which may function as a receptor for some physiological events in bone.

31176 **Ab initio quantum mechanical characterization of the ground electronic states of uracil, 5-fluorouracil, thymine, 5-trifluoromethyluracil, and their 6-SCH_3 anion derivates.** Lin, J. (Univ. of Illinois, Chicago); LeBreton, P.R.; Shipman, L.L. *J. Phys. Chem.;* **84**: No. 4, 431-435(21 Feb 1980).

The molecular fragment floating spherical Gaussian orbital method has been used to investigate the molecular orbital structure and π-charge distributions of uracil (Ura), 5-F-Ura, thymine (Thy), 5-CF_3-Ura, 6-SCH_3-Ura anion, 5-F-6-SCH_3-Ura anion, 6-SCH_3-Thy anion, and 5-CF_3-6-SCH_3-Ura anion. For each of the eight species, the total π populations and bond orders were compared. For each of the four neutral molecules, the populations and bond orders for the lowest unoccupied molecular orbitals (LUMOs) were compared; the results indicate that the experimentally observed site specificity for nucleophilic attack (i.e., the C_6 position) is electronically controlled in that the LUMO has its highest density at C_6. For the four anionic species, the populations and bond orders for the highest occupied molecular orbitals (HOMOs) were compared; the results indicate that the site specificity for the enzymatic π-electrophilic attack on the anion is electronically controlled in that the HOMO has its highest density at C_5. For the addition of bisulfite in substituted uracils in vitro, the first step of the reaction involves the-nucleophilic attack of the sulfur atom at C_6. The second and rate-determining step under low general acid concentration involves σ-electrophilic attack of a proton onto the oxygen (O_5) bound to C_4. Calculations show that the number of electrons on O_5 in the anionic reaction intermediate and the O_5-protonation energy decreases in the order 5-F-Ura > Ura > Thy, an identical ordering to that found for the overall reaction rates for bisulfite addition under conditions of low general acid concentration. Thus the overall rate for bisulfite addition correlates well with the basicity of O_5 in the anionic reaction intermediate.

31177 **Some invariant properties of IgE-mediated basophil activation and desensitization.** Goldstein, B.; Dembo, M.; Sobotka, A.K.; Lichtenstein, L.M. (Los Alamos Scientific Lab., NM). *J. Immunol.;* **123**: No. 4, 1873-1882(Oct 1979).

We investigate certain general properties of antigen induced degranulation of sensitized basophils by analyzing two types of experiments: experiments in which we expose basophils to two

antigens seuquentially and then determine the fraction of histamine released; and experiments in which we obtain time-dependent release and desensitization curves. To analyze the latter type of experiments we introduce a new way to plot release and desensitization data that depends on the nature of the interactions of histamine-containing units (histamine quanta) with themselves or the cells degranulation apparatus, but not on any specific properties of the antigen. From our analysis we conclude that: (1) a fraction of histamine within a population of basophils is nonreleasable by antigenic stimulation. (2) When a basophil degranulates the initial release of histamine appears to inhibit subsequent release. (3) The rate of histamine release is proportional to the amount of releasable histamine remaining in the cells when the amount remaining is small, as expected if release of histamine granules is a stochastic process. (4) There is no dependence of desensitization on the extracellular calcium concentration.

31178 Degranulation of human basophils: quantitative analysis of histamine release and desensitization, due to a bivalent penicilloyl hapten. Dembo, M.; Goldstein, B.; Sobotka, A.K.; Lichtenstein, L.M. (Los Alamos Scientific Lab., NM). *J. Immunol.;* **123**: No. 4, 1864-1872(Oct 1979).

We present a quantitative model of histamine release from human basophils due to the symmetric divalent hapten, Bis benzylpencilloyl 1,6 diaminohexane, $(BPO)_2$. The major elements of model are (1) The histamine content of basophils is divided into a large number of discrete and quasi-independent quanta. (2) A certain fraction of the quanta in a population of basophils are nonreleasable. (3) Release of the contents of a quanta is a stochastic event. (4) the binding and cross-linking reaction between $(BPO)_2$ and cell surface IgE approaches thermal equilibrium on a time scale that is very short compared to the time scale of histamine release from or desensitization of basephils. (5) The probability per unit time of the release event, P/sub R/, is a function of the extracellular calcium concentration [Ca]/sub ex/, and of the number of cross-linked IgE molecules per cell, X/sub poly/. In addition, the functional dependence of P/sub R/ on X/sub poly/ for fixed [Ca]sub ex/ is sigmoid, and the dependence of P/sub R/ on [Ca]/sub ex/ is such that P/sub R/ $\rightarrow 0$ as [Ca]/sub ex/ $\rightarrow$ [for all values of X/sub poly. (6) Antigen-specific IgE molecules and/or their associated Fe receptors are inactivated at a rate that is a saturable function of X/sub poly/. Furthermore, this process of inactivation is not dependent on the extracellular calcium concentration. The model is tested by carrying out a detailed fitting to histamine release data obtained by using cells from a single donor. Good agreement between theory and experiment is obtained, and all the parameters of the mode are determined. The ways in which the model can be extended to include systems more complex than the $(BPO)_2$ system are briefly discussed.

31179 Shared N-terminal sequences in monoclonal IgMk and IgGk proteins from a patient with a complex multiple paraprotein disorder. Hopper, J.E.; Noyes, C.; Hsu, R.; Heinrikson, R.; Gallagher, W. (Univ. of Chicago, IL). Contract EY-76-C-02-0069. *J. Immunol.;* **122**: No. 5, 2007-2010(May 1979).

The N-terminal sequence analyses were preformed on the heavy (H) and light (L) chains of the idiotypically identical IgMk and IgGk paraproteins isolated from the serum of patient, Cam. The N-terminal 39 residues of the k chains of the IgM and IgG were identical and belonged to the human V/sub kIII/ subgroup. This sequenced stretch included the first L chain hypervariable region. The N-terminal 27 residues of the variable regions (V/sub H/) of the respective μ and γ heavy chains were also identical and belonged to the human V/sub HIII/ subgroup. These identical V/sub H/ sequences were unique with lysine residues at positions 13 and 19. This dual lysine substitution has not been seen in 37 other human V/sub HIII/ sequences reported in the literature. This N-terminal sequence homology in the V-regions of Cam IgMk and IgGk paraproteins and the shared idiotypy expressed by Cam IgM, IgG, and IgA proteins strongly suggest the existence of complete structural homology in the variable regions of the H and L chains of these Ig molecules of three separate Ig classes. At the cellular and genetic level, these results point toward a common clonal origin for the idiotypically related Ig molecules and suggest that identical V-region (V/sub H/ and V/sub L/) genes were utilized by the Cam lymphoid clone in the biosynthesis of the respective IgM, IgG, and IgA proteins.

31180 Evidence for shared idiotypy expressed by the IgM, IgG, and IgA serum proteins of a patient with a complex multiple paraprotein disorder. Hopper, J.E.; Haren, J.M.; Kmiecik, T.E. (Univ. of Chicago, IL). Contract EY-76-C-02-0069. *J. Immunol.;* **122**: No. 5, 2000-2006(May 1979).

The results of a comparative idiotypic analysis of multiple Ig paraproteins isolated from the serum of an individual patient, Ca, with Sjoegren's syndrome and Waldenstroem's macroglobulinemia are reported. At initial presentation, Ca serum was found to contain two major paraproteins, an IgMk and an IgGk, together with a small elevation in the level of IgA protein. The patient's clinical course was characterized by dramatic and opposing changes in the respective serum levels of the IgMk and IgGk paraproteins over an extended time period that coincided in part with received chemotherapy. Idiotypic antigenic analysis of the IgMk and IgGk paraproteins revealed that the two monotypic proteins shared identical idiotypic determinants. The Ca IgA serum fraction, specifically isolated by an immunoabsorbent and free of any IgG and IgM, was shown to possess idiotypic determinants identical to the IgG and IgM proteins. In extensive tests of specificity, the idiotypic determinants shared by Ca IgM, IgG, and IgA proteins were not present in large excesses of heterologous IgM and IgG, nor on Ig molecules contained in a large number of normal and myeloma sera.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 30998, 31192

31181 (BNL—28066) **Excision repair of bulky lesions in the DNA of mammalian cells.** Setlow, R.B.; Grist,E. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract AC02-76CH00016. 8p. NTIS, PC A02/MF A01.

The report examines the process of excision repair of pyrimidine dimers from uv-irradiated and chemically challenged human cells. It is shown by means of a sensitive endonuclease assay that the amount of excision observed depends upon the isotope used to label cells, and that XP heterozygotes are between normals and XPs. (ACR)

31182 (BNL—28104) **Isolation and purification of retinals from purple membranes for mass spectral analysis.** Seltzer, S.; Lin, M. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract AC02-76CH00016. 9p. NTIS, PC A02/MF A01.

A method is described for separating and purifying retinal from the purple membrane of Halobacteria by means of methylene chloride or chloroform extraction. (ACR)

31183 (CONF-791059—7) **Binding of B(a)P diol epoxide to chromosomal histone proteins.** Kootstra, A.; Cronen, M.C.; Slaga, T.J. (Tennessee Univ., Oak Ridge (USA). Graduate School of Biomedical Sciences; Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 20p. NTIS, PC A02/MF A01.

From 4. international symposium on polynuclear aromatic hydrocarbons; Columbus, OH, USA (2 Oct 1979).

In order to understand how a chemical such as benzo(a)pyrene [B(a)P] exerts its carcinogenic effect, a fundamental knowledge is required concerning the interaction of metabolites of B(a)P with the macromolecules of the eukaryotic cell and the consequences of such interaction at the molecular level. Since current evidence suggests that the DNA is an important target of the ultimate carcinogenic form of B(a)P, the B(a)P diol epoxide, we have studied the binding of B(a)P diol epoxide (anti) to chromatin in vitro, in order to obtain some information about the interaction of this carcinogen with the various components of chromatin.

31184 (DOE/ER/03326—90) **Photochemistry and enzymology of photosynthesis. Progress report, November 1, 1979-March 31, 1980.** Radmer, R.; Golbeck, J.; Velthuys, B. (Martin Marietta Labs., Baltimore, MD (USA)). Apr 1980. Contract AC02-76ER03326. 11p. NTIS, PC A02/MF A01.

Progress is reported for the period November 1979 through March 1980. Specific projects reported on are: (1) light harvesting and electron transport in C_4 plants; (2) mass spectrometer studies of photosynthetic O_2 evolution; (3) biochemical studies on chloroplast copper proteins; and (4) electron transport in green plants. (ACR)

31185 Formation of enzyme-bound and medium pyrophosphate and the molecular basis of the oxgyen exchange reaction of yeast inorganic pyrophosphatase. Janson, C.A.; Degani, C.; Boyer, P.D. (Univ. of California, Los Angeles). *J. Biol. Chem.;* **254**: No. 10, 3743-3749(25 May 1979).

Yeast inorganic pyrophosphatase, with 10 mM ^{32}Pi and 10 mM Mg^{2+} present at pH 7.3 to 8.6 rapidly forms enzyme-bound pyrophosphate equivalent to about 5% of the total catalytic sites on the two enzyme subunits. The enzyme thus appears to bind PPi so as to favor thermodynamically its formation from Pi. The enzyme catalyzes a measurable equilibrium formation of free PPi at a much slower rate. Under similar conditions, the enzyme catalyzes a rapid exchange of oxygen atoms between Pi and water with the relative activation by metals being $Mg^{2+} > Zn^{2+} > Co^{2+} > Mn^{2+}$. Millisecond mixing and quenching experiments demonstrate that the rate of formation and cleavage of the enzyme-bound PPi is rapid enough to explain most or all of the oxygen exchange reaction.

CYTOLOGY

REFER ALSO TO CITATION(S) 31173, 31174, 31177, 31178, 31201, 31202, 31227

31186 (COO—2486-369-1) **DNA replication and the repair of DNA strand breaks in nuclei of Physarum polycephalum. Terminal report, August 1, 1978-March 31, 1980.** Brewer, E.N.; Evans, T.E. (Case Western Reserve Univ., Cleveland, OH (USA). Dept. of Radiology). 1980. Contract AS02-76EV02486. 16p. NTIS, PC A02/MF A01.

Nuclei isolated from Physarum are able to replicate approximately 15% of the total genome in a manner which is qualitatively similar to the DNA replication process occurring in the intact organism. Such nuclei, however, are defective in the joining of Okazaki intermediates in vitro. Two DNA polymerase species, isolated from nuclei or intact plasmodia of this organism, can be separated by sucrose density gradient centrifugation. Total DNA polymerase activity is low in nuclei isolated during mitosis. A heat-stable glycoprotein material present in aqueous nuclear extracts stimulates DNA synthesis in well-washed nuclei. A sub-nuclear preparation active in DNA synthesis in vitro has been obtained from isolated nuclei of Physarum. Radiation-induced DNA double-strand breaks are rejoined in intact plasmodia and isolated nuclei of Physarum in a cell cycle-dependent manner. This phenomenon does not appear to be due to an intrinsic difference in nuclear DNA endonuclease activity at different times of the mitotic cycle. DNA strand breaks and repair induced by the carcinogen 4-nitroquinoline-1-oxide is similar in several respects to that resulting from exposure of the organism to ionizing radiation. Temperature sensitive strains of Physarum have been constructed and preliminary genetical and biochemical characterizations have been carried out. Two of the strains appear to be conditionally defective in DNA metabolism. An isogenic ploidal series of amoebae has been prepared and characterized as to uv and ionizing radiation sensitivity (in terms of cell survival). There is a direct relationship between ploidy and resistance to uv whereas ploidal change does not appear to affect the response to ionizing radiation.

31187 (DOE/EV/10327—1) **Molecular events basic to cellular radiation response. Progress report, October 1, 1978-September 30, 1979.** Kolodny, G.M. (Beth Israel Hospital, Boston, MA (USA). Div. of Nuclear Medicine). 1980. Contract AC02-80EV10327. 35p. NTIS, PC A03/MF A01.

Research during the past year has been directed at induction of specific protein synthesis in differentiated mammalian cells. The Primer Hypothesis for the regulation of eukaryotic gene expression suggests that RNA transcription is primed by small molecular weight RNA. It predicts that albumin mRNA transcription in a 3T3 fibroblast, which ordinarily does not produce albumin, can be initiated by RNA primer present in liver cells. In experiments this past year, mouse fibroblasts were incubated with mouse liver RNA. These cells did indeed produce albumin which was detected by counterimmunoelectrophoresis. Confluent 3T3 cell cultures were incubated with mouse liver RNA and polylysine in serum free media. Counterimmunoelectrophoresis (CIEP) of the dialyzed and lyophilized media against mouse albumin antisera gave a single precipitin line indicating albumin snthesis by the fibroblasts. The synthesis of this protein immunologicaly similar to albumin required new albumin mRNA transcription since it was not synthesized in the presence of actinomycin, could be found in media which had been incubated with RNA significantly smaller in size than albumin mRNA, and was synthesized in the absence of added poly A containing RNA. These results represent the first reported demonstration that RNA can be taken up from the media by cells in culture, and can induce in those cells the production of a differentiated cell product not ordinarily synthesized by those cells, i.e, a change in the normal transcription pattern in those cells.

31188 (LA—8245-PR) **Automated cancer-cell sorting and analysis. Midyear progress report, June-December 1979.** Mullaney, P.F.; Martin, J.C.; Steinkamp, J.; Svitra, Z. (Los Alamos Scientific Lab., NM (USA)). Jul 1980. Contract W-7405-ENG-36. 15p. NTIS, PC A02/MF A01.

This report covers the work performed under Interagency Agreement N01 60311 from June through December 1979. The LASL dual-laser cell sorter has been evaluated with CHO, Colo, and CaSki cells stained with mithramycin and two protein stains. All the deliverables called for in this program have been completed and are awaiting shipment to NCI. The computerization of this sorter is in progress, and some refabrication of the parabolic chamber is required before evaluation can be completed. Plans for the second 6-month portion of the program are also discussed.

31189 Inhibition of human lymphocyte transformation of oxygenated sterol compounds. Yachnin, S.; Hsu, R. (Univ. of Chicago, IL). *Cell. Immunol.;* **51**: No. 1, 42-54(Apr 1980).

Oxygenated sterol compounds (OSC), potent inhibitors of sterol synthesis in both resting and mitogen-stimulated human lymphocytes, are capable of suppressing the DNA-synthetic response of human peripheral blood lymphocytes to mitogenic lectins, anti-human thymocyte antiserum, and the mixed lymphocyte culture. The most potent OSC are 20α-hydroxycholesterol and 25-hydroxycholesterol, which inhibit DNA synthesis in mitogen stimulated lymphocytes at 7.4 and 3.9 x 10^{-6}M, respectively. Lymphocytes which have been exposed to OSC for 18 hr and washed free of inhibitor are fully capable of DNA synthesis when subsequentlc challenged with mitogen. Suppression of DNA synthesis by OSC is not apparent during the first 24-40 hr of culture. The inhibition of lymphocyte DNA synthesis by OSC can be partially reversed by the addition of 10^{-2}M mevalonate to the culture. Sterol synthesis by mitogen-stimulated lymphocytes is enhanced by culturing them in medium supplemented with lipoprotein (and cholesterol-)depleted serum. In such medium, the 50% inhibitory doses of 25-hydroxycholesterol for suppression of both mitogen-stimulated lymphocyte DNA and sterol synthesis are approximately equal (≃3 x 10^{-7}M). Sterol synthesis is a necessary, but not sufficient, part of the program of lymphocyte proliferative response to mitogens; the evidence presented suggests that lymphocytes can utilize exogenous sterol at least partially for the purpose of cell replication.

TRACER TECHNIQUES

31190 (BNL—27909) **Hungry granulocyte: its fate and regulation of production.** Cronkite,E.P. (Brookhaven National Lab., Upton, NY (USA)). 1978. Contract AC02-76CH00016. 30p. NTIS, PC A03/MF A01.

The granulocyte, a phagocytic anti-1 bacterial defense cell, is discussed. Its production, the kinetics of its proliferation, the regulation of its production, and its loss from the blood are reviewed. (ACR)

GENETICS

REFER ALSO TO CITATION(S) 31174, 31205

31191 (BNL—28042) **Movable genetic elements: detection of changes in maize DNA at the Shrunken locus due to the intervention of Ds elements.** Burr, B.; Burr, F.A. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract AC02-76CH00016. 7p. (CONF-800595—1). NTIS, PC A02/MF A01.

From Cold Spring Harbor symposium No. 45: movable genetic elements; Cold Spring Harbor, NY, USA (28 May 1980).

This report describes our initial attempts at the molecular characterization of a maize controlling element. We have prepared a cDNA probe and used it to detect changes at a locus where Ds elements are found. Evidence of their presence are indicated by changes in the restriction patterns, but there is as yet no information on the physical nature of the controlling elements nor on the kinds of rearrangements they cause.

TRACER TECHNIQUES

31192 (UCRL—84292) **Structure, evolution and expression of insulin genes.** Cordell, B.; Lebo, R.V.; Yu, L.C.; Lau, Y.F.; Carrano, A.V.; Goodman, H.M. (California Univ., San Francisco (USA). Howard Hughes Medical Inst. Lab.; California Univ., Livermore (USA). Lawrence Livermore Lab.). 1980. Contract W-7405-ENG-48. 5p. (CONF-800233—1). NTIS, PC A02/MF A01.

From 6. international congress on endocrinology; Melbourne, Australia (10 Feb 1980).

Since the initial discovery of insulin by Banting and Best in 1922 enoromous progress has been made in understanding the role of this hormone in the control of diabetes and in regulating glucose homeostasis in vertebrates. However, until very recently, little was known abut the structure of the insulin genes or the control of insulin gene expression in the normal and pathological state. We have been studying the structure of the rat and human genes encoding preproinsulin and the chromosomal location of the human gene. In addition, we have reintroduced the isolated insulin genes into mammalian cells growning in culture in order to study the molecular events associated with insulin expression. A summary of our recent findings is reported here.

METABOLISM

REFER ALSO TO CITATION(S) 31174

MEDICINE

REFER ALSO TO CITATION(S) 31220

UNSEALED RADIONUCLIDES IN DIAGNOSTICS

REFER ALSO TO CITATION(S) 31017

31193 Specific radioimmunoassay of human β-endorphin in unextracted plasma. Wiedemann, E. (Univ. of California, Berkeley); Saito,

T.; Linfoot, J.A.; Li, C.H. *J. Clin. Endocrinol. Metab.;* **49**: No. 3, 478-480(Sep 1979).

With an antiserum against human β-endorphin (β-EP) cross-reacting <2% with human β-lipotropin (β-LPH) by weight we have developed a radioimmunoassay that can detect 1 pg β-EP in diluted raw plasma. In a.m. fasting plasma of 14 normal subjects β-EP ranged from <5 to 45 pg/ml. β-EP was elevated in untreated, but normal in successfully treated Cushing's disease; undetectable in a patient with adrenal adenoma; extremely high in Nelson's syndrome; and elevated in a patient with bronchogenic carcinoma before, but undetectable after tumor resection. In subjects with intact hypothalamic-pituitary-adrenal axis, β-EP was undectectable after dexamethasone and increased after metyrapone administration and insulin-induced hypoglycemia. β-EP concentration was considerably lower in serum than in simultaneously collected plasma, but increased in serum left unfrozen for several hours after clot removal. Thus, β-EP behaves like a hormone responding to the same stimuli as ACTH and β-LPH and blood appears to contain enzymes both generating and destroying immunoreactive β-EP.

EXTERNAL RADIATION IN DIAGNOSTICS

REFER ALSO TO CITATION(S) 31016

31194 (COO—2777-04) **Evaluative studies in nuclear medicine research. Progress report, October 1, 1979-June 30, 1980.** Potchen, E.J. (Michigan Research Center, Okemos (USA)). Jul 1980. Contract AS02-76EV02777. 23p. NTIS, PC A02/MF A01.

Effort since the last progress report (September 1979) has been directed toward assessing the potential short and long term benefits of continued development and application and medical research of emission computed tomograhy (ECT). This report contains a review of existing ECT technology, including functional descriptions of current and proposed image systems, for both snglephoton ECT (SPECT) and positron ECT (PECT) approaches. Medical research and clinical topics to which ECT has been, or may be, applied are presented. One such area of investigation involves the effects of stroke. The application of ECT to laboratory research, and to clinical diagnosis and prognosis, of stroke may result in improved management of the disease. An illustration of the potential savings in the cost of management of stroke due to the effects of applied ECT research is included. The results represent a compilation of data collected from conversations with, and conference presentations by, ECT users, researchers and image system designers, and from a review of the literature.

31195 **Nitrogen-13-labeled ammonia for multiple daily needs in a nuclear medicine clinic.** MacDonald, N.S.; Cook, J.S.; Birdsall, R.L.; McConnel, L.J. (Univ. of California, Los Angeles). *Trans. Am. Nucl. Soc.;* **33**: 927-928(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

EXTERNAL RADIATION IN THERAPY

REFER ALSO TO CITATION(S) 31207, 31209, 31210, 31212, 31215, 31216

31196 (FDA—80-8119) **Measurements of emission levels during microwave and shortwave diathermy treatments.** Ruggera, P.S. (Bureau of Radiological Health, Rockville, MD (USA)). May 1980. 22p. Bureau of Radiological Health, Rockville, MD.

Shortwave and microwave diathermy treatments are used to relieve pain through the noninvasive application of electromagnetic energy to body tissues. In administering these treatments, not all of the energy is confined to the treatment area. This stray radiation exposes unintended tissue of the patient and also can expose the operator (physical therapist, coach, and so forth). This study was conducted to quantify the exposure levels experienced by the operator during diathermy treatments. For the three microwave units surveyed, with the operator standing at the controls of the diathermy console, the maximum measured power density was 1.3 mW/cm² (equivalent to 70 V/m and 0.19 A/m in free space). For the six shortwave units surveyed, with the operator standing at the controls of the diathermy console, the maximum measured field strengths were 0.47 A/m and 250 V/m (equivalent to free-space power densities of 8.3 mw/cm² and 16.6 mW/cm²). If the operator moved closer to the applicator during the treatment, the exposures would be much higher. This survey indicates a need for suppression of unnecessary radiation from the applicators of microwave diathermy units, and from the applicators and cables of shortwave diathermy units.

MICROBIOLOGY

REFER ALSO TO CITATION(S) 30405, 30408, 30410, 31150

31197 (DOE/ET/20604—1) **Bioengineering aspects of inorganic carbon supply to mass algal cultures. Final report.** Goldman, J.C. (Woods Hole Oceanographic Institution, MA (USA)). Jun 1980. Contract AS02-78ET20604. 104p. NTIS, PC A06/MF A01.

The work included in this report is part of an ongoing study (currently funded by the Solar Energy Research Institute - Subcontract No. XR-9-8144-1) on the inorganic carbon requirements of microalgae under mass culture conditions and covers the period June 1, 1978 through May 31, 1979. It is divided into two parts appended herein. The first part is a literature review on the inorganic carbon chemical system in relation to algal growth requirements, and the second part deals with the kinetics of inorganic carbon-limited growth of two freshwater chlorophytes including the effect of carbon limitation on cellular chemical composition. Additional experiment research covered under this contract was reported in the Proceedings of the 3rd Annual Biomass Energy Systems Conferences, pp. 25-32, Bioengineering aspects of inorganic carbon supply to mass algal cultures. Report No. SERI/TP-33-285.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 31185

PATHOLOGY

REFER ALSO TO CITATION(S) 31179, 31180, 31202, 31234

31198 (DOE/EV/00910—52) **Bovine lymphocytic leukemia: studies of etiology, pathogenesis and mode of transmission. Progress report, November 1, 1979-October 31, 1980.** Sorensen, D.K. (Minnesota Univ., St. Paul (USA). Coll. of Veterinary Medicine). Jun 1980. Contract AS02-76EV00910. 11p. NTIS, PC A02/MF A01.

The primary project objectives are to elucidate the cause(s) and early pathogenesis of the adult form of lymphosarcoma in cattle. This goal is to be accomplished through experimental transmission of the disease. For these studies large quantities of bovine leukemia virus (BLV) were propagated in short-term, mitogen stimulated, lymphocyte cultures. Cultures containing abundant BLV particles were pooled (33 liters total) and further processed by continuous flow, density gradient, ultracentrifugation. This higly concentrated, cell free, BLV preparation was then used as inoculum for 12 late stage bovine fetuses (inoculated in utero) and two newborn calves. Extensive monitoring studies have been carrid out on these inoculated animals to detect precancerous changes and to obtain a detailed description of the events preceding the development of lymphosarcoma. These extensive records on lymphosarcoma associated blood parameters have established that all of the inoculated animals became persistently BLV infected. However, after more than five years of incubation, no cases of lymphosarcoma developed. Consequently, during the past seven months, five of these well characterized animals have been subjected to frequent BLV re-exposure in order to study BLV-host interactions in previously infected adults and to potentially accelerate tumor formation in these animals.

31199 **Spontaneous endomyometrial neoplasms in aging Chinese hamsters.** Brownstein, D.G.; Brooks, A.L. (Inhalation Toxicology Research Inst., Albequerque, NM). *J. Natl. Cancer Inst.;* **64**: No. 5, 1209-1214(May 1980).

Twenty-one endomyometrial neoplasms among 93 nulliparous noninbred Chinese hamsters were evaluated. The median survival time of the 93 females was 1040 days. The median age of hamsters with endomyometrial neoplasms was 1200 days. Neoplasms were classified as carcinomas or malignant mixed muellerian tumors of the endometrium and benign or malignant myometrial neoplasms. There were 13 endometrial adenocarcinomas. Three tumors were mixed adenosquamous carcinomas, which occurred in significantly older Chinese hamsters than did adenocarcinomas. Three malignant mixed muellerian tumors consisted of 2 carcinosarcomas and 1 mixed mesodermal tumor. The 2 myometrial neoplasms were a lelomyoma and a lelomyosarcoma. The classification and relative frequency of these neoplasms were similar to endomyometrial neoplasms of women, which makes Chinese hamsters useful subjects for studies of spontaneous endomyometrial cancers.

PHYSIOLOGICAL SYSTEMS

REFER ALSO TO CITATION(S) 30962, 31174, 31175, 31199

31200 (LMF—68) **Respiratory measurements in small laboratory mammals: a literature review.** Likens, S.A.; Mauderly, J.L. (Lovelace Foundation for Medical Education and Research, Albuquerque, NM (USA). Inhalation Toxicology Research Inst.). Jul 1979. Contract AC04-76EV01013. 49p. NTIS, PC A03/MF A01.

Reports pertaining to the measurement of respiratory variables in small laboratory mammals have been collected from the open literature. The techniques reported from 1941 to June 1978 for measurement of breathing pattern, lung volumes, transpulmonary pressure, lung mechanics and gas exchange in small mammals are presented. A brief chronological history of publication of these techniques and a listing of typical applications is also included. Reported values for healthy mice, rats, hamsters, guinea pigs and rabbits have been summarized in tubular form.

31201 Growth factors. Golde, D.W.; Herschman, H.R.; Lusis, A.J.; Groopman, J.E. *Ann. Intern. Med.;* **92**: No. 5, 650-662(May 1980).

Humoral regulation of somatic and hematopoietic cell growth has been intensely investigated during the past decade. Growth hormone is unique because it regulates the size of the person within the constraints of the genetic program. The somatomedins and insulin growth factors are low molecular weight polypeptides believed to mediate some functions of growth hormone. Epithelial growth factor and nerve growth factor are well-characterized polypeptides that influence the growth and differentiation of epithelial and neural tissues and interact with specific cell surface receptors. The hematopoietins are a family of polypeptide hormones that specifically regulate the proliferation and differentiation of stem cells giving rise to erythrocytes, granulocytes, monocytes, megakaryocytes, and B and T lymphocytes. Platelet-derived growth factor modulates the proliferation of fibroblasts in vitro and may have a role in the development of atherosclerosis and myelofibrosis. New knowledge on the biochemistry and physiology of growth factors will probably have a substantial impact on our understanding of human diseases involving abnormal cell growth.

31202 Comparison of simian virus 40-induced mouse and hamster tumor-specific transplantation antigens. Coggin, J.H. Jr. (Univ. of South Alabama, Mobile). Contract EE-77-S-05-5601. *J. Natl. Cancer Inst.;* **63**: No. 4, 1029-1034(Oct 1979).

The tumor-specific transplantation antigen (TSTA), which appears on papovavirus-induced sarcomas of the hamster, has been demonstrated to be common in any cell type transformed by a given virus. Other studies have suggested that cell-free TSTA has been successfully isolated from mouse sarcoma cells induced in vitro by simian virus 40 (SV40). Considerable work has been done toward purifying and identifying this mouse TSTA. We obtained preparations from the laboratory reporting the isolation of TSTA from the SV40-induced mouse sarcoma cells as well as cell lines from which the preparations of TSTA had been derived. These extracts, as well as fresh extracts made from the appropriate SV40-induced mouse tumor line, were tested for their ability to interrupt tumor production in mice after challenge with homologous and heterologous sarcomas and to prevent SV40 primary tumor induction in hamsters. The findings indicated that TASTA extracted from SV40-induced mouse sarcoma cells as well as from the intact irradiated mouse sarcoma cells failed to prevent SV40 oncogenesis as well as tumor transplantation in the hamster, but it was capable of preventing specific tumor transplantation when used as a vaccine in mice. Human and hamster cells transformed by SV40 were capable of interrupting SV40 oncogenesis in the hamster. These results suggested that the so-called TSTA, which is immunogenic and induces specific transplantation resistance in mice to SV40-induced mouse sarcomas, was not the same TSTA that appears on human, rat, and hamster cells and that is produced by SV40 in those cell types. Further, tumor antigen may be the immunizing component which others have isolated as a transplantation-like antigen from mouse sarcoma cells. An alternative explanation would be a peculiar histocompatibility (H-2) barrier in the hamster to the immunogenicity of TSTA induced in mouse cells.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 31193

PUBLIC HEALTH

31203 (SAND—80-7088C) **Risk to animal health from pathogens in municipal sludge.** Yeager, J.G. (BDM Corp., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 29p. (CONF-800495—1). NTIS, PC A03/MF A01.

From Evaluation of health risks associated with animal feeding and/or land application of municipal sludge conference; Tampa, FL, USA (29 Apr 1980).

Public and legislative concerns directed toward resource and materials recycling have stimulated widespread interest in the use of sewage sludge to improve the fertility and water-holding capacity of soil. The use of sludge on land to grow crops for human or animal consumption has raised concerns over the health hazards from the sludge pathogens. Relatively little attention has been focused on the risks to the health of animals that may graze on sudge-amended pastures or consume feedstuffs grown on these lands. Concern about the animal health risks is justified because economic losses from animal disease that may be associated with the use of sewage sludge could be quite large. In fact, these losses may exceed poential economic losses from human disease associated with sludge use. This review emphasizes the risk to animal health from zoonotic and human pathogens in sludge and from specific animal pathogens that may be found in sludge.

AGRICULTURE AND FOOD TECHNOLOGY

REFER ALSO TO CITATION(S) 31198, 31228

31204 (LA—8227-PR) **Animal disease detection using a new rapid method for monitoring antigen-induced lymphocyte stimulation, October 1, 1978-September 30, 1979.** Tate, E.H.; Cram, L.S. (Los Alamos Scientific Lab., NM (USA)). Jun 1980. Contract W-7405-ENG-36. 15p. NTIS, PC A02/MF A01.

Lymphocyte proliferation in response to bovine tubercular antigen was measured on blood samples from a herd naturally infected with TB. Determination of single-cell DNA content as a measure of cell proliferation was done by flow cytometry after staining with the DNA-specific stain, propidium iodide. Results of the field testing showed good agreement with other methods for TB detection. Significant progress on the development of a new method for TB detection was made. An increase in the rate of amino acid uptake can be measured within 14 h after treatments of lymphocytes from TB-positive animals with TB antigen. The enhancement does not occur after similar treatment of lymphocytes from TB-negative animals. Ways for optimizing the new test and investigations into other new diagnostic techniques are reported.

31205 Immediate effect of male and female gametes and N on five pearl millet grain characteristics. Burton, G.W.; Rabson, R.; Axmann, H. (Office of Health and Environmental Research, Washington, DC). Contract DE-AS09-76EV00637. *Crop Sci.;* **20**: No. 1, 7-9(Jan-Feb 1980).

Pearl millet, Pennisetum americanum (L.) Leeke, inbreds Tift 12, Tift 13, Tift 18DB, Tift 23DB, Tift 239DB, and Bil 3B were grown in the field in plots fertilized with 15, 80, or 150 kg/ha of N with P and K adequate to study the immediate effect of male and female gametes and N on five pearl millet grain characteristics. Plants were replicated four times. Within each N-treatment plot selfed, sibbed, open-pollinated, and intermated seed was produced so that each genotype supplied both female and male gametes. Grain characteristics determined were thousand-kernel weight (TKW), total amino N and proline (Pro) N of grain acid hydrolysates, N/Pro ratio, and dye-binding capacity (DBC). Nitrogen treatments affected all grain characteristics except the N/Pro ratio, female gametes affected all grain characteristics, and male gametes affected TKW, proline and the N/Pro ratio significantly. The female effect was greater than the male effect. Open-pollinated seed was significantly higher than self-pollinated seed in all characteristics measured. The data show that pollen source has as immediate effect on three of the pearl millet grain characteristics measured. They also indicate that self-pollinated seed of pearl millet and perhaps other cross-pollinated crops should be used for the most accurate assessment of grain characteristics of any genotype. A minimum seed population and a standard pollen source could serve as an alternate but less desirable substitute for selfed seed for crops with a high degree of self-incompatibility.

BIOMEDICAL SCIENCES, APPLIED STUDIES

RADIATION EFFECTS ON BIOCHEMICALS

IN VITRO

31206 (COO—3501-14) **Biological effects of ionizing radiation at the molecular, cellular, and organismal levels. Triennial progress report, October 15, 1977-October 14, 1980.** Lange, C.S. (Rochester Univ., NY (USA). School of Medicine and Dentistry). 1980. Contract AS02-76EV03501. 13p. NTIS, PC A02/MF A01.

Two major accomplishments have been achieved in the past three years with the support of this contract. Firstly, the original Zimm theory of rotor speed dependent DNA sedimentation has been tested quantitatively and found to be correct, i.e., T4c and T4D+ DNAs sedimented with S°/sub 20,w/ values as predicted by the equation of Zimm and Schumaker. Furthermore, the quantitative validity of the theory means that the size (M/sub r/) of a DNA sedimenting under speed-dependent conditions is not undefinable but

rather can be uniquely obtained by the application of that theory to the data. Secondly, the viscoelastic recoil (Γ_{11}), or more accurately, the zero shear rate reduced recoil (Γ/sub 11, r, o/) has been shown to be a quantitative direct function of the number of intact (T4c) DNA molecules present (per ml) in solution. This demonstration made possible the measurement of a direct survival curve for intact DNA molecules (i.e., without double-strand breaks) after exposure to ionizing radiation. A /sub DNA/D_{37} of 47.4 krads was obtained for the DNA of T4c coliphage irradiated in air as a solution of phage particles. It is noteworthy that this survival curve measures the number of intact DNA molecules, not the average number of breaks/molecule.

RADIATION EFFECTS ON CELLS

EXTERNAL SOURCE

REFER ALSO TO CITATION(S) 31186, 31187, 31212

31207 Interaction of radiation and cyclophosphamide in intestinal crypt cells. Phillips, T.L.; Ross, G.Y.; Goldstein, L.S. (Univ. of California, San Francisco). Contract EY-76-C-03-1012. *Int. J. Radiat. Oncol., Biol. Phys.;* **5**: No. 9, 1441-1444(Sep 1979).

From Conference on combined modalities: chemotherapy/radiotherapy. Part 2; Hilton Head Island, SC, USA (15 Nov 1978).

LAF_1 mice were used to study the interaction of radiation and cyclophosphamide using the intestinal crypt survival technique. The LD/sub 50/60/ for cyclophosphamide was 340 mg/kg and the MTD (LD_{01}) was 250 mg/kg. The MTD dose caused only 35% kill of intestinal crypt cells when given 3 hr after 1100 rad. The results were the same when drug was given 2 hr before irradiation. MTD doses given from -48 to +48 hr relative to a radiation dose of 1100 rad caused survival fluctuations from 10 to 50 crypt cells with minima at -18 and +12 hr and maxima at -36 and +24 hr, suggesting a periodicity of about 30 hr. Radiation survival curves determined 2 hr after administration of the MTD have the same slope as controls and the extrapolated curve yields a D/sub q/ of 400 rad. A 3 hr interval, 2-dose experiment yielded a survival ratio of 6 for control and 15 for cyclophosphamide treated animals. Cyclophosphamide appears to have minimal activity in intestinal crypt cells and there does not appear to be any interaction between the drug and radiation lesions.

31208 Enhancement effects of high-energy neon particles in the viral transformation on mouse C3H1OT1/2 cells in vitro. Yang, T.C.H.; Tobias, C.A.; Blakeley, E.A.; Craise, L.M.; Madfes, I.S.; Perez, C.; Howard, J. (Univ. of California, Berkeley). Contract W-7405-ENG-48. *Radiat. Res.;* **81**: No. 2, 208-223(Feb 1980).

The enhancement effects of X rays and high-LET particles on the viral transformation of cultured mammalian cells were studied. Confluent mouse C3H1OT1/2 cells, x-irradiated immediately after infection with Simian virus (SV40), showed a higher frequency of transformation than cells infected only with the virus. The enhancement of viral transformation appeared to be dose-dependent and more than additive. The number of transformations per cell increased with dose and reached a maximum at about 300 rad. The frequency of transformation per survivor was enhanced linearly with the square of the x-ray dose. Compared to X rays, neon particles with a residual range of 12.7 g/cm^2 in water were much more efficient in enhancing the viral transformation of cells. The number of transformants per plated cell reached a peak around 200 rad. The RBE for enhancing the frequency of transformation per survivor appeared to vary with dose, being higher at lower dose. For the 50% survival level dose of neon ions, the RBE was found to be about 2.28 compared to about 1.84 for the 10% survival level dose. A decrease in the enhancement effect was found as the interval between the irradiation and viral infection was extended. This suggests that the cells in the G_1 phase can repair the radiation-induced lesions that are responsible for the observed increase of transformation. The recovery rate for cells irradiated with neon ions, however, was much slower than that for cells irradiated with X rays.

31209 Effect of bleomycin on aerated and hypoxic cells in vitro, in combination with irradiation. Roizin-Towle, L.; Hall, E.J. (Columbia Univ., New York, NY). Contract EP-78-S-02-4733. *Int. J. Radiat. Oncol., Biol. Phys.;* **5**: No. 9, 1491-1494(Sep 1979).

From Conference on combined modalities: chemotherapy/radiotherapy. Part 2; Hilton Head Island, SC, USA (15 Nov 1978).

Hamster V79 cells, cultured in vitro, were treated for 4 hr at 37.5°C with graded concentrations of bleomycin (BLM). Cells were found to be significantly more resistant to the drug under hypoxic than under aerated conditions. When misonidazole was used in combination with BLM, the survival of hypoxic cells was reduced below that for aerated cells. The cytotoxicity of BLM was observed to be greatly enhanced at elevated temperatures. Experiments in which both BLM and x-rays were used indicate additivity of effects when the 2 modalities are applied together. The cell killing potential of a combination of given doses of x-rays and BLM is greatly enhanced by a time interval between the 2 treatments of sufficient duration for the resistant survivors of the first treatment to move into a sensitive phase of the cell cycle before the second is delivered.

31210 Interaction of irradiation and BCNU in intestinal crypt cells. Goldstein, L.S.; Ross, G.Y.; Phillips, T.L. (Univ. of California, San Francisco). Contract EY-76-C-03-1012. *Int. J. Radiat. Oncol., Biol. Phys.;* **5**: No. 9, 1569-1571(Sep 1979).

From Conference on combined modalities: chemotherapy/radiotherapy. Part 2; Hilton Head Island, SC, USA (15 Nov 1978).

Survival of intestinal crypt cells was used to evaluate radiation and BCNU injury in LAF_1 mice. A dose of 25 mg/kg reduced the crypt cell survival to 35% of irradiated control levels, if BCNU was given 3 hr post-irradiation. Drug was more effective when given pre-irradiation from -18 to -2 hr than post-irradiation (1210 rad) from 3 to 48 hr. When a radiation survival curve was determined 2 hr after the MTD dose, the slope was similar to controls, but a shift was caused by cell kill. When BCNU was given 2 hr before a 3 hr split-radiation, the survival ratio was 4 to 7 which was comparable to the control values. Although BCNU appears to enhance radiation cell kill when given before radiation, it does not appear to inhibit the repair of radiation-induced damage. Irradiation may alter the repair mechanism of cells damaged by BCNU.

BASIC STUDIES

REFER ALSO TO CITATION(S) 31208

RADIATION EFFECTS ON PLANTS

BASIC STUDIES

31211 (DOE/EV/02283—1) **Response of a forest ecotone to ionizing radiation. Progress report, October 15, 1979-October 14, 1980.** Murphy, P.G.; Sharitz, R.R. (Michigan State Univ., East Lansing (USA); Savannah River Ecology Lab., Aiken, SC (USA)). Jul 1980. Contract AC02-76EV02283. 16p. NTIS, PC A02/MF A01.

Compositional and structural characteristics of three forest types, including aspen dominated, maple-birch dominated, and an intervening ecotone, were studied before and after irradiation in northern Wisconsin. Irradiation occurred during the summer of 1972. By the summer of 1973 the density of viable tree seedlings at 10 m from the radiation source was substantially reduced in all three areas relative to the preirradiation densities of 1971. As of the summer of 1979, establishment of tree seedlings continued to be inhibited by the vigorous development of ground vegetation. In most respects, the ecotone has shown properties and responses to radiation intermediate to those observed in the aspen and maple-birch areas. The rate and compositional characteristics of succession in the ecotone relative to aspen and maple-birch forest types is presently under study.

RADIATION EFFECTS

RADIATION EFFECTS ON ANIMALS

31212 Fundamental questions in the combined use of radiation and chemicals in the treatment of cancer. Elkind, M.M. (Argonne National Lab., IL). Contract W-31-109-ENG-38. *Int. J. Radiat. Oncol., Biol. Phys.;* **5**: No. 9, 1711-1720(Sep 1979).

From Conference on combined modalities: chemotherapy/radiotherapy. Part 2; Hilton Head Island, SC, USA (15 Nov 1978).

The author gives answers in regard to combined chemotherapy/radiotherapy basic questions. A discussion of cell properties, dosimetry, treatment-induced cellular changes, cell killing enhancement, and general properties of antineoplastic drugs is given with experimental data being cited for reference material.

MAN

31213 (CONF-800601—2) **Utilization of critical periods during development to study the effects of low levels of environmental agents.** Russell, L.B. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 19p. NTIS, PC A02/MF A01.

From 13. Rochester international conference on environmental toxicity--measurement of risks; Rochester, NY, USA (2 Jun 1980).

Careful definition of critical periods in the development of selected characters can result in experimental systems that may be highly useful in studying risk at low levels of exposure. Three examples are presented. Epidemiological investigations can lose much of their value unless critical periods are known for the end points being studied.

31214 (CONF-800736—1) **Some properties of the log-Laplace distribution.** Uppuluri, V.R.R. (Union Carbide Corp., Oak Ridge, TN (USA). Computer Sciences Div.). 1980. Contract W-7405-ENG-26. 11p. NTIS, PC A02/MF A01.

From Research conference and international summer school on statistical distributions in scientific work; Trieste, Italy (23 Jul 1980).

A random variable Y is said to have the Laplace distribution or the double exponential distribution whenever its probability density function is given by $\lambda \exp(-\lambda \text{ abs. value } y)$, where $-\infty < y < \infty$ and $\lambda > 0$. The random variable $X = \exp(Y)$ is said to have the log-Laplace distribution. With the problem of extrapolation to low doses in dose response curves as motivation, an axiomatic characterization of the log-Laplace distribution is obtained. 1 figure.

31215 **Preliminary report of a cooperative randomized study for the treatment of localized small cell lung carcinoma.** Seydel, H.G. (Thomas Jefferson University Hospital, Philadelphia, PA); Creech, R.H.; Mietlowski, W.L.; Perez, C.A. *Int. J. Radiat. Oncol., Biol. Phys.;* **5**: No. 9, 1445-1447(Sep 1979).

From Conference on combined modalities: chemotherapy/radiotherapy. Part 2; Hilton Head Island, SC, USA (15 Nov 1978).

An analysis of 171 of 222 entered patients with localized small cell lung cancer after randomization to four treatment arms has been carried out. All patients received radiation therapy (4500 rad to the primary tumor and draining lymph nodes). One group of patients received no other treatment; the second group received cyclophosphamide (CY) during radiation therapy and CY and CCNU following radiation therapy; the third group received prophylactic brain irradiation (3000 rad in 10 fractions); and the fourth group received both prophylactic CY and CCNU as well as brain irradiation. Patients who did not receive CY and CCNU initially were treated upon relapse with the same CY/CCNU regimen. There is a significant difference in the incidence of brain metastases between the arms containing prophylactic brain irradiation or treatment at time of recurrence. The difference in brain metastases following prophylactic chemotherapy or chemotherapy at time of recurrence is of borderline significance. All treatment arms remain coded, but 17 to 19% of patients in each treatment arm had local and 43 to 52% had distant relapse. Two percent of patients had severe esophagitis and pneumonitis related to the radiation therapy regimen. Twenty to 24% of the patients in the chemotherapy groups have had severe bone marrow and GI toxicity. No patients have died of treatment-related toxicity. Patients with complete responses have a significantly longer median survival than those with partial or no responses.

31216 **Pathologic stages I and II Hodgkin's disease, 1968-1975: relapses and results of retreatment.** Mintz, U.; Miller, J.B.; Golomb, H.M. (Univ. of Chicago, IL). Contract EY-76-C-02-0069. *Cancer;* **44**: No. 1, 72-79(Jul 1979).

Sixty-seven previously untreated patients with Hodgkin's disease, pathologic stages I and II, seen during a 7-year period were evaluated with respect to initial staging and treatment, as well as relapse and retreatment results. The initial treatment consisted of radiation therapy (RT) to an involved field (IF) or an extended field (EF) for patients with stages IA and IIA, or RT and, in recent cases, combination chemotherapy [cyclophosphamide, Oncovin, procarbazine, and prednisone (COPP)] for patients with stages IB and IIB. Nineteen of the 67 patients relapsed (28%), including 11 of 56 patients with stages IA and IIA (20%) and 8 of 11 patients with stages IB and IIB (73%). Seventeen of the 19 relapses occurred within 24 months after completion of the initial therapy (89%). The relapse-free survival at 5 years was 75% for the A patients and 25% for the B patients. The actuarial survival of stage IA and IIA patients at 5 years was 91%; there was no significant difference between patients treated initially with either IF or EF. The actuarial survival at 5 years for the patients with stages IB and IIB was 88%, as most responded to a second program of induction therapy. No correlation could be found between the pattern of relapse and the initial pathologic stage or the mode of treatment.

VERTEBRATES

REFER ALSO TO CITATION(S) 31207, 31209, 31210

31217 **Synergism of diethylstilbestrol and radiation in mammary carcinogenesis in female F344 rats.** Holtzman, S.; Stone, J.P.; Shellabarger, C.J. (Brookhaven National Lab., Upton, NY). Contract EY-76-C-02-0016. *J. Natl. Cancer Inst.;* **63**: No. 4, 1071-1074(Oct 1979).

One compressed 20-mg pellet containing cholesterol only or cholesterol mixed with 0.98, 1.6, 2.6, or 3.9 mg of diethylstilbestrol (DES) was implanted into each of 203 female F344 rats. Two days later, half the animals in each group were exposed to 150 R of x rays, and the other half were sham irraidated. the rats were maintained until 350 days post implantation. Mortality increased with the higher doses of DES, with or without x rays. DES at all dose levels, with or without x rays, produced pituitary tumors and pyometritis. Only rats that received both DES and x rays had mammary adenocarcinomas (AC). A synergistic AC response was found in the group that received 2.6 mg DES plus x rays. Synergism was defined as a significantly greater incidence of rats with mammary neoplasia resulting from DES plus x-ray treatment when compared to the summed incidence from comparable individual treatments. For all other groups of rats that received both treatments, synergism was detected only when their data were combined. Synergism was not detected among rats that had fibroadenomas (FA). Both types of neoplasms were independent phenomena because no significant relationship was found between the incidences of FA and AC.

RADIONUCLIDE EFFECTS - INTERNAL SOURCE

ANIMALS

REFER ALSO TO CITATION(S) 31219, 31221

31218 **Age and its influence on effects of iodine-131 in guinea pig thyroid glands.** Book, S.A.; McNeill, D.A.; Spangler, W.L. (Univ. of California, Davis). *Radiat. Res.;* **81**: No. 2, 254-262(Feb 1980).

To identify the differences in age-related radiosensitivity of the thyroid gland to radioiodine exposure, we exposed fetal, neonatal, weanling, and adult guinea pigs to single graded doses of ^{131}I. Injected quantities ranged from 1 to 100 μCi ^{131}I, depending on the age group, and resulted in thyroid doses ranging from hundreds to tens of thousands of rad. At approximately 100 days of age (or 100 days after dosing for adults), a single microcurie of ^{131}I was given and animals were killed 1 day later to provide data on thyroid weight and percentage ^{131}I uptake. Analysis of these data and information on pathology suggested that the fetal and weanling guinea pig thyroid glands were more radiosensitive than the adult thyroid; the neonatal thyroid appeared less radiosensitive than that of the adult. The increase in radiosensitivity of the young thyroid glands over the adults, however, did not appear to be greater than twofold. Nevertheless, the demonstration of age-related radiosensitivity requires that it be considered by those who assess radiologic risks to human populations.

NUCLIDE KINETICS AND TOXICOLOGY

ANIMALS

REFER ALSO TO CITATION(S) 31218

31219 **Fraction of energy absorbed from β-emitting particles in the rat lung.** Snipes, M.B. (Inhalation Toxicology Research Inst., Albuquerque, NM). Contract EY-76-C-04-1013. *Radiat. Res.;* **81**: No. 2, 161-169(Feb 1980).

Forty-four male Fischer-344 rats were exposed, nose only, to a relatively insoluble aerosol of ^{144}Ce-labeled fused aluminosilicate particles. Fractional β energy absorption was measured 7 to 9 days after exposure for 28 rats (ages 12 to 25 weeks and body weights of 183 to 337 g); lung burdens were 13 to 82 nCi. An additional group of 16 rats was exposed when 12 weeks old and maintained for 6 months prior to analysis; body weights and lung burdens 6 months after exposure ranged from 276 to 368 g and 16 to 46 nCi, respectively. Lungs were carefully removed, inflated, and frozen by immersion in liquid nitrogen. The energy spectrum from each lung was measured in a 4π β spectrometer, keeping the lung frozen throughout this procedure. Over the range of lung sizes in this study (0.88 to 1.66 g) the mean fractional energy absorption and standard deviation were $0.23 +- 0.078$, respectively. Results agreed well with theory, indicating that calculated values for fractional energy absorption in the lung can be used for a range of lung sizes and β energies. Calculated values for fractional energy absorption as a function of β energy are included for several lung sizes between 0.5 and 10 g.

31220 **Specific sequestering agents for the actinides. 4. Removal of $^{238}Pu(IV)$ from mice by sulfonated tetrameric catechoyl amides.** Durbin, P.W.; Jones, E.S.; Raymond, K.N.; Weitl, F.L. (Univ. of California, Berkeley). *Radiat. Res.;* **81**: No. 2, 170-187(Feb 1980).

The similar chemical properties of Fe(III) and Pu(IV) - small ionic size, high charge, and high acidity - and the great stability of the complexes of Fe(III) with ligands secreted by microorganisms, specifically those containing the catechoyl (o-dihydroxybenzoic acid) functional group, suggested that tetracatechoyl ligands would be efficient in vivo sequestering agents for Pu(IV). Cyclic (CY) and linear (LI) tetracatechoyl amides (CAM) connected by ethylene, propylene, and/or butylene bridges were synthesized and administered intraperitoneally to mice (20 to 30 μmole/kg) 1 h after injection of about 1.5 μCi/kg of $^{238}Pu(IV)$ citrate. The mice were killed 24 h after the ^{238}Pu injection, and the ^{238}Pu in tissues and excreta was measured by using the L X rays. The prototype CAM ligand, 3,3,3,3-CYCAM, bound circulating $^{238}Pu(IV)$, but the complex could not be excreted. Sulfonation of the benzene rings produced

ligands (CAMS) that were soluble in water and stable to air oxidation. The linear 3,3,3-LICAMS was more efficient than its cyclic analog, 3,3,3,3-CYCAMS; ^{238}Pu excretions were 44 and 35% of the injected dose, respectively. Lengthening the intergroup bridges to expand the metal coordination cavity (4,4,4-LICAMS or 3,4,3-LICAMS) increased ^{238}Pu excretion to 65%; an equimolar amount of $CaNa_3DTPA$ promoted 63% ^{238}Pu excretion. The advantages of the CAMS ligands are: (a) low reactivity at pH 7 with divalent metals - their depletion is the cause of DTPA toxicity; (b) moderate toxicity - all CAM ligands except 4,4,4-LICAMS were tolerated by mice at the dosage administered; and (c) removal of some ^{238}Pu already deposited in the skeleton - 3,4,3-LICAMS reduced skeletal ^{238}Pu to 0.29 of the 1-h control value compared to a reduction to 0.56 by $CaNa_3DTPA$.

31221 Comparative effects of iodine-132 and iodine-131 in rat thyroid glands. Book, S.A.; McNeill, D.A.; Parks, N.J.; Spangler, W.L. (Univ. of California, Davis). *Radiat. Res.;* **81**: No. 2, 246-253(Feb 1980).

The thyroidal effects of short-lived radioiodines such as ^{132}I, ^{133}I, and ^{135}I have not been well defined. We report here the results of a study comparing the effects of ^{132}I and ^{131}I. We found the same effect in goitrogen-stimulated rat thyroid glands (in terms of 50% suppression of thyroid gland weight increase) at injected activities of 93 μCi ^{132}I and 13 μCi ^{131}I. Doses, however, were 3 rad/μCi ^{132}I and 194 rad/μCi ^{131}I. The same 50% suppression for thyroid dose was found to occur at about 280 rad from ^{132}I and 2500 rad from ^{131}I, suggesting an approximately ninefold increase in radiologic effectiveness of ^{132}I over ^{131}I.

THERMAL EFFECTS

CELLS

REFER ALSO TO CITATION(S) 30251

INVERTEBRATES

REFER ALSO TO CITATION(S) 31222

VERTEBRATES

31222 (EPRI-EA—1402(Vol.1)) **Methodology for assessing population and ecosystem level effects related to intake of cooling waters. Volume 1. Handbook of methods: population level techniques. Final report.** Alevras, R.A.; Dew, C.B.; Pikitch, E.K.; Wyman, R.L.; Lawler, J.P.; Norris, R.A.; Weiss, S.L. (Lawler, Matusky and Skelly, Pearl River, NY (USA)). Jun 1980. 400p. NTIS, PC A17/MF A01.

Various techniques related to assessing power-plant-induced mortality at the population level are presented. A broad range of techniques is presented through a review of past experience, examples using real or simulated data from power plant studies and new techniques developed for this methodology. The detailed information needed by an investigator to select those techniques most appropriate for the assessment problem at hand is provided. Guidance is provided for the interpretation of the results of various analyses where appropriate. The major subjects reviewed include techniques for estimating entrainment and impingement mortality, techniques for estimating population size, hydrologically based models for assessment, the use of length data for assessment, the Leslie Matrix Model, population response analysis, including a computer program for reproductive value, stock-recruitment relationships and life cycle models.

31223 (EPRI-EA—1402(Vol.2)) **Methodology for assessing population and ecosystem level effects related to intake of cooling waters. Volume 2. Handbook of methods community analysis techniques. Final report.** Logan, D.T.; Moy, S.S.; Norris, R.A.; Sydor, W.J. (Lawler, Matusky and Skelly, Pearl River, NY (USA)). Jun 1980. 318p. NTIS, PC A14/MF A01.

Techniques of community analysis applicable to assessment of biological changes resulting from cooling water withdrawal are presented. Four general areas are considered; stability, diversity, and niche theory; patterns in distance and time; ecological simulation modeling; and other approaches. The two former areas are judged the most useful and are reviewed in depth, from historical development and basic principles through increasingly complex and demanding methods. Several computer programs with example output are provided. Guidance is given for effective experimental design, choice of appropriate technique of analysis, application, and interpretation. For single utilities, thoughtfully designed experimental and monitoring programs and thorough analysis of empirical data are recommended. Ecological simulation modeling should be reserved for large, multiple-impact situations and should be used to direct, integrate and guide study programs.

CHEMICALS METABOLISM AND TOXICITY

REFER ALSO TO CITATION(S) 30140

31224 (ANL/ES—90, pp 130-183) **Ecological impacts of emissions from battery cycles.** May 1980.

In Ecological and biomedical effects of effluents from near-term electric vehicle storage battery cycles.

The biogeochemistry and impacts of the major expected constituents of emissions from the battery cycle are discussed. The discussion lays the foundation for assessing the types of impacts that may result from further development of battery technology. Quantitative assessments are based upon the numbers generated in Section 5 and represent predictions of anticipated impacts. The estimates are tentative and will change as the pathways to be followed by the developing technologies become better defined.

31225 (EPA—600/7-79-009) **Interagency program in energy-related health and environmental effects research. Project status report.** (Environmental Protection Agency, Research Triangle Park, NC (USA). Health Effects Research Lab.). Jan 1979. 167p. NTIS.

Projects reported in this document are grouped under one of four major research areas. The first area is identification of hazardous agents associated with non-nuclear energy technologies. These projects involved the development of qualitative methods for the identification of hazardous materials. The second area is development of more rapid and sensitive methods to evaluate dose to man. These projects focused on the development of quantitative methods for measuring degree of toxicity of various pollutants. The third area is determination of the metabolism and fate of hazardous agents associated with energy technologies. These projects involved determination of the physiological activities of several known carcinogens. The fourth research area is evaluation of hazards to man. In addition to studies of the effects of certain pollutants on human, several of the projects concerned preparation of standard pollutant samples for use in future studies to increase the comparability of results. A list of additional studies funded under this program is included.

CELLS

REFER ALSO TO CITATION(S) 30225

31226 (CONF-800742—1) **Induction of mutation and differentiation in mammalian cells by chemicals which initiate or promote tumor formation.** Huberman, E. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 13p. NTIS, PC A02/MF A01.

From 2. international congress on toxicology; Brussels, Belgium (6 Jul 1980).

A cell-mediated mutagenesis assay was developed to predict the potential carcinogenic hazard of some environmental chemicals. In this assay, cells with appropriate markers for mutagenesis, such as the Chinese hamster V79 cells, are co-cultivated with cells capable of metabolizing chemical carcinogens. Use of this assay made it possible to demonstrate a relationship between the degree of carcinogenicity and mutagenicity of a series of polycyclic hydrocarbons, nitrosamines and aflatoxins, and to establish means to study organ specificity of some chemical carcinogens. However, most short term in vitro assays are designed to detect mutagenic activity and therefore do not detect tumor promoting agents which are devoid of this activity. By analyzing various markers of terminal differentiation in cultured human melanoma and myeloid leukemia cells, we have established a relationship between the activity of a series of tumor promoting phorbol diesters in the mouse skin and their ability to induce terminal differentiation. We suggest that measuring alterations in the differentiation characteristics of some cultured cells may represent an approach by which environmental tumor promoting agents can be studied and detected.

31227 (DOE/ET/13557—14) **Evaluation of the mouse micronucleus test as compared with the in vivo cytogenics test for mutagenicity of synthetic fuel materials. Topical report.** (Meyer (A.F.) and Associates, Inc., McLean, VA (USA)). 9 Mar 1980. Contract AC02-79ET13557. 7p. NTIS, PC A02/MF A01.

This brief topical report, provides information on a comparison of the mouse micronucleus mutagenic test proposed by a DOE contractor (FMC) for coal derived chemicals; as compared with the in vivo cytogenic test. The latter procedure is repotedly preferred by EPA authorities connected with implementation of the toxic substances control act (TOSCA). This evaluation was performed at the request of Headquarters DOE program management staff. The mouse micronucleus test takes less time and costs approximately one-fourth that of the in vivo cytogenetic procedure. This topical report is written to the extent possible in non-technical language to present conclusions associated with the evaluation rather than a detailed scientific dissertation.

MICROORGANISMS

REFER ALSO TO CITATION(S) 30225, 31241

PLANTS

31228 (BNL—27597) **Yield responses of field-grown soybeans exposed to simulated acid rain.** Evans, L.S.; Conway, C.A.; Lewin, K.F. (Brookhaven National Lab., Upton, NY (USA)). Mar 1980. Contract AC02-76CH00016. 9p. (CONF-800365—2). NTIS, PC A02/MF A01.

From International conference on the ecological impact of acid precipitation; Sandefjord, Norway (11 Mar 1980).

An important area of interest is to determine the effects of acid precipitation on the yield of agronomic crops under field conditions. Experiments described herein were performed with field-grown soybeans at Brookhaven National Laboratory during the summer of 1979. A preliminary experiment was performed the preceding year at the same site to estimate the most appropriate plot design and statistical analyses. Soybeans were seeded to provide six Latin Squares. Five treatments (no rain, simulated rainfalls of pH levels of 4.0, 3.1, 2.7, and 2.3) replicated five times in each Latin Square were used to produce a total of 30 plots per treatment. These results show that additions of small amounts of simulated acid rain to soybeans decreased the number of pods per plant. This decrease in the number of pods per plant produced a small but significant decrease in seed mass. The decreases (3, 5 and 8% at simulated rain pH levels of 4.0, 3.1, and 2.7) were present in soybeans already exposed to rainfalls at Brookhaven National Laboratory with an average H^+ concentration of about pH 4.0 over the period of this experiment.

31229 (BNL—51195) **Proceedings of the international workshop on the effects of acid precipitation on vegetation, soils, and terrestrial ecosystems, Brookhaven National Laboratory, June 12 to 14, 1979.** Evans, L.S.; Hendrey, G.R. (eds.). (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract AC02-76CH00016. 57p. NTIS, PC A04/MF A01.

The objectives of the workshop were to determine the levels of current knowledge of the effects of acid precipitation on vegetation, soils, and terrestrial ecosystems; research needed in these areas to understand the environmental impacts of acid rain; and to help coordinate research groups to avoid excessive duplication of research. The workshop was designed so that researchers in the areas of effects of acid precipitation on vegetation, soils, and whole ecosystem approaches could communicate effectively. There was a general consensus that acid rain at extreme ambient levels, or in artificial systems that simulate extreme ambient levels, causes injury to plant tissues. A major area of concern of acid rain injury was thought to be plant reproduction. The overall levels of significance of plant injury among various plant species remain unknown. The most important priorities in the area of effects of acid rain on crops were an evaluation of effects on crop yields and interaction of acid rain in combination with pollutants on various plants. Few participants thought that ambient acid rain loadings have altered soils to such a degree that plants are affected at present, but many thought that acid rain could cause some alterations in soils. The most important research priorities were in the areas of the effects of acid rain on increased leaching of exchangeable plant nutrients and alterations in phosphorous availability. All participants agreed that there are alterations in terrestrial ecosystems from acid precipitation. However, no demonstrated harmful effects were presented from natural ecosystems. Further research on the effects of acid rain on terrestrial ecosystems should be directed mostly toward the interaction of acid rain with toxic elements such as Al, Fe, and Mn and on the effects on nutrient cycling, especially that of nitrogen.

31230 (CONF-800680—2) **Toxicity of shale oil to freshwater algae: comparisons with petroleum and coal-derived oils.** Giddings, J.M. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 15p. NTIS, PC A02/MF A01.

From Symposium on health effects investigations of oil shale development; Gatlinburg, TN, USA (23 Jun 1980).

The toxicities of various water-soluble fractions of Paraho/SOHIO shale oils and coal liquefaction products to the algae Selenastrum capricornutum and Microcystis aeruginosa are investigated. Photosynthetic inhibition is the criterion of toxicity. A secondary objective of the algal bioassay is determination of the range of toxic concentrations. (ACR)

INVERTEBRATES

REFER ALSO TO CITATION(S) 31162

VERTEBRATES

REFER ALSO TO CITATION(S) 31169, 31217

31231 (CONF-800498—1) **Studies on the mechanisms of action of modifiers of skin carcinogenesis.** Slaga, T.J. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 37p. NTIS, PC A03/MF A01.

From Symposium on mutagenesis and carcinogenesis; Warsaw, Poland (21 Apr 1980).

Skin tumors can be induced by the sequential application of a subthreshold dose of a carcinogen (initiaton phase), followed by repetitive treatment with a weak or noncarcinogenic tumor promoter. There is a very good dose-response relationship between the induction of the number of papillomas per mouse at early times (10 to 20 weeks) by either tumor initiators and promoters and the final carcinoma incidence after a longer latency (20 to 50 weeks) in SENCAR mice. This system not only can be used to determine the tumor initiating and promoting activities of a compound but if the agent is given repeatedly by itself one can also determine if it is a complete carcinogen, i.e., if it has both tumor initiating and promoting activity. There is a good correlation between the tumor-initiating activities of PAH and their abilities to bind covalently to DNA. In addition, various inhibitors of PAH tumor initiation show a strong correlation with their abilities to inhibit the binding of the PAH to DNA and their anti-tumor initiating activities. There is also a good correlation between the promoting abilities of phorbil esters to promote tumors and their abilities to induce ornithine decarboxylase (ODC), cell proliferation and dark basal keratinocytes. However, when other nonpromoting hyperplastic agents are used only dark cell induction correlates. Certain polyamines and prostaglandins can enhance phorbol ester tumor promotion. Anti-inflammatory steroids, retinoids and protease inhibitors are potent inhibitors of tumor promotion. They inhibit tumor promotion by either inhibiting the 12-0-tetradecanoylphorbol-13-acetate (TPA)induced cell proliferation, ODC and/or dark basal keratinocytes. Certain weak promoters such as mezerein which mimics TPA in many biochemical and morphological effects are potent second step promoters in a two-stage promotion regimen.

31232 (LMF—67) **Evaluation of a recently designed multi-tiered exposure chamber.** Beethe, R.L.; Wolff, R.K.; Griffis, L.C.; Hobbs, C.H.; McClellan, R.O. (Lovelace Foundation for Medical Education and Research, Albuquerque, NM (USA). Inhalation Toxicology Research Inst.). Nov 1979. Contract AC04-76EV01013. 17p. NTIS, PC A02/MF A01.

We have evaluated a newly designed multi-tiered chamber intended for inhalation studies. Our particular concerns were the aerosol concentration distribution within the chamber and the resultant lung deposition in exposed animals. Our findings may be summarized as follows: aerosol concentrations were found to vary only 5-9% for different locations within the chamber for a variety of conditions tested; aerosol size distributions were constant throughout the chamber; lung deposition in rats was also found to be quite uniform for rats at different locations throughout the chamber; light levels and ammonia levels were acceptable; and animal handling characteristics were excellent. We have found this to be an excellent chamber which combines the economic advantages of reduced animal care and floor space requirements with good aerosol distribution characteristics. Because of the slight side-to-side variation in concentration it would be advisable, as a precaution, to rotate animals from tier to tier throughout a chronic exposure so that animals spend equal times on each tier.

31233 **Chromium levels in fish from a lake chronically contaminated with chromates from cooling towers.** Elwood, J.W.; Beauchamp, J.J.; Allen, C.P. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Int. J. Environ. Stud.;* 14: No. 4, 289-297(1980).

Chromium concentrations of several fish species [bluegill (Lepomis macrochirus), largemouth bass (Micropterus salmoides) goldfish (Carassius auratus), and mosquitofish (Gambusia affinis)] from White Oak Lake (WOL), a small impoundment which formerly received cooling water blowdown containing high Cr(VI) concentrations, were measured to determine levels of tissue accumulation. Chromium concentrations in the muscle and/or whole body (excluding G.I. tract) of some species in some years were found to be negatively correlated with total fish weight. Results suggest that Cr levels in muscle and whole body of most species analyzed from WOL and from Melton Hill Reservoir, an uncontaminated impoundment, may be inversely related to fish weight. Muscle and whole-body Cr concentrations were not significantly different from each other in bluegill or largemouth bass. With the exception of goldfish collected in 1969, between species comparisons of chromium levles in WOL fish within years showed no statistically significant differences, indicating that there was not trophic level effect on Cr accumulation in tissues of the species examined.There was also no significant difference in Cr concentration in muscle of bluegill and largemouth bass from WOL and Melton Hill Reservoir, indicating that these species either effectively regulate their Cr absorption or that the elevated Cr levels in WOL were in a form that is unavailable for absorption into tissues.

31234 Selective protective effect of butylated hydroxytoluene against 1,2-dimethylhydrazine carcinogenesis in BALB/c mice. Clapp, N.K.; Bowles, N.D.; Satterfield, L.C.; Klima, W.C. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *J. Natl. Cancer Inst.;* **63**: No. 4, 1081-1087(Oct 1979).

The effect of the antioxidant butylated hydroxytoluene (BHT) was determined in 1,2-dimethylhydrazine (DMH) colon carcinogenesis. The following groups were comprised of female and male BALB/c mice that were either: (1) given BHT (0.75% in the feed) for life beginning at 8 weeks of age; (2) inoculated with DMH (20 mg/kg body wt) sc for 10 weeks beginning at 11 weeks of age; (3) treated with BHT plus DMH; or (4) maintained as untreated controls. Mice of both sexes treated with BHT plus DMH had increased survival over those given DMH alone (females: 93 vs. 64%, P = 0.011; males: 92 vs. 57%, P<0.001). Adenomas and adenocarcinomas were induced by DMH primarily in the descending colon and rectum in both sexes; tumor incidences were reduced in male mice given BHT plus DMH compared with the incidence in males treated with DMH (34 vs. 75%, P = 0.0036), but not in females (60 vs. 50%). The numbers of tumors per tumor-bearing mouse were reduced in both sexes given BHT plus DMH as compared with mice given DMH alone ($\approx$ 2.0 to $\approx$ 1.0). Neither BHT-treated mice nor untreated controls had colon or rectal tumors. DMH induced lung tumors, but BHT did not; tumor incidences in mice treated with BHT plus DMH were intermediate between those in mice given DMH or BHT alone. The sex-specific protective effect of BHT on the survival of mice treated with DMH and on the tumor incidences in the large bowel (males only) resembled the sex-specific effect of BHT on diethylnitrosamine-induced squamous cell tumors of the forestomach (females only), but the mechanisms remain unexplained and may be quite different.

31235 Lead decorporation following therapy with the dibutyl ester of diethylenetriaminepentaacetate in the mouse. Sorensen, E.M.B.; Moretti, E.S.; Lindenbaum, A. (Argonne National Lab., IL). *Bull. Environ. Contam. Toxicol.;* **22**: No. 4/5, 617-624(Jul 1979).

In previous work to increase the effectiveness of unesterified DTPA for removal of actinides, the dibutyl ester of DTPA (Bu_2DTPA) was synthesized. Because this molecule has a reduced charge and increased lipid solubility compared to either EDTA or DTPA, it should be more capable of crossing the blood-brain barrier, be potentially more effective in reducing otherwise refractory brain burdens of lead, and possibly more effective in reversing brain damage. The therapeutic efficacy of this ester was tested, using both mature and immature mice with a well-established lead burden, the latter to simulate treatment of young children following lead poisoning. This study was designed to determine whether the dibutyl ester can mobilize more lead from mouse tissues compared to DTPA and EDTA, whether it promotes urinary or fecal excretion of lead, and whether any prolonged effect occurs after discontinuation of treatment.

31236 Effects of three diets on mercury excretion after methylmercury administration. Landry, T.D.; Doherty, R.A.; Gates, A.H. (Univ. of Rochester, School of Medicine, NY). *Bull. Environ. Contam. Toxicol.;* **22**: No. 1/2, 151-158(May 1979).

In mice it is suggested that dietary components may influence absorption and excretion of Hg compounds. This possibility was examined by determining the effects of (1) an evaporated whole milk diet, (2) a chemically defined liquid diet, and (3) a pelleted rodent diet on Hg retention in mice after administration of an apparently non-toxic dose of methylmercury (MeHg). Whole body Hg elimination and fecal and urinary Hg excretion were measured daily for two weeks. Two weeks after MeHg administration, Hg concentrations in whole body, brain, liver, kidney and whole blood were determined. The diet groups showed differences in whole body Hg retention and fecal Hg excretion.

31237 Toxicity and teratogenicity of aromatic amines to Xenopus laevis. Dumont, J.N. Schutz, T.W.; Jones, R.D. (Oak Ridge National Lab., TN). *Bull. Environ. Contam. Toxicol.;* **22**: No. 1/2, 159-166(May 1979).

Chemical analyses of possible effluents from pilot coal conversion facilities reveal that they contain five major classes of organic compounds: (1) phenols, (2) monoaromatic hydrocarbons, (3) polyaromatic hydrocarbons, (4) arylamines, and (5) sulfur-containing compounds. Quinoline and its methyl-substituted derivatives are examples of such compounds and are present in significant quantities in waters from coal conversion processes. It is the purpose of this report to examine the toxicity and teratogenicity of several pure aromatic amines known to be present in coal conversion process waters on the early embryonic stages of, South African clawed frog, Xenopus laevis.

MAN

REFER ALSO TO CITATION(S) 31213

31238 (ANL/ES—90, pp 184-273) **Biomedical and health effects of emissions from the battery cycles.** May 1980.

In Ecological and biomedical effects of effluents from near-term electric vehicle storage battery cycles.

The biological and medical effects of the toxic agents identified as being of concern to human health in an expanded production of the three near-term EV battery systems, lead/acid, Ni/Zn, and Ni/Fe, are discussed in this section. In addition, known effects of these agents on human health are identified. For each toxic agent, the following information is reviewed and evaluated: pathways for tissue uptake, retention, and excretion; toxic responses; and means for protection from exposure, remediation of toxic responses, and diagnosis of the extent of exposure. The focus is on the chemical forms of these toxic agents, the modes of human exposure, and the levels of exposure anticipated as being relevant to battery production for EV use. For the lead/acid battery, the toxic agents reviewed are lead (Pb), stibine (SbH_3), arsenic (As), arsine (AsH_3), and antimony trioxide (Sb_2O_3). For the Ni/Fe and Ni/Zn systems, nickel, cobalt, and cadmium are reviewed for their potential impact on human health from occupational and environmental exposures. An assessment is also presented of the human health impact that may result from central power station emissions required to charge 10,000 battery-powered EVs for civilian use. A demographic projection analysis is used to evaluate the impact of various vehicle and battery configurations in terms of their impacts on life shortening in a general population.

31239 (DOE/CH/93010—1) **Health effects of fossil-fuel combustion products: needed research.** (National Academy of Sciences - National Research Council, Washington, DC (USA). Div. of Medical Sciences). 1980. Contract AT02-76CH93010. 78p. NTIS, PC A05/MF A01.

An examination is made of the research needed to expand and clarify the understanding of the products of fossil-fuel combustion, chiefly that taking place in stationary sources of power. One of the specific objectives that guided the study on which this report is based was to identify the pollutants potentially hazardous to man that are released into the environment in the course of the combustion of fossil fuels. The hazards of principal concern are those which could cause deleterious, long-term somatic and genetic effects. Another objective was to specify the nature of the research needed to determine the health effects of these pollutants on the general population. Special attention was paid to the interaction of pollutants; the meteorologic and climatic factors that affect the transport, diffusion, and transformation of pollutants; the effects of concentrations of aerosol, particulate, and thermal loads on biologic systems; and the susceptibility of some portions of the population to the effects of pollutants on the skin and cardiovascular, pulmonary, and urinary systems. Other objectives were to evaluate the methods of the proposed research, including analytic and interpretation techniques, to identify fields in which the available scientific information is inadequate for regulatory decision-making and to recommend a research program to meet those deficiencies, and to provide a logical framework within which the necessary information can be developed (the proposed program is presented in terms of subject, methods, and priorities).

31240 Cadmium and lead levels in blood and urine in a series of cardiovascular and normotensive patients. Khera, A.K. (Univ. of Aston, Birmingham, England); Wibberley, D.G.; Edwards, K.W.; Waldron, H.A. *Int. J. Environ. Stud.;* **14**: No. 4, 309-312(1980).

The mean blood-lead, blood-cadmium, urine-lead and urine-cadmium levels of a series of male Caucasian patients suffering from cardiovascular disease were significantly higher at every age group than the corresponding levels in a control series of normotensive patients.

31241 Concentration-dependent mutation by alkylating agents in human lymphoblasts and Salmonella typhimurium: N-methyl-N-nitrosourethane and β-propiolactone. Penman, B.W.; Hoppe, H. IV; Thilly, W.G. (Massachusetts Inst. of Tech., Cambridge). Contract EE-77-S-02-4267. *J. Natl. Cancer Inst.;* **63**: No. 4, 903-907(Oct 1979).

The toxic and mutagenic effects of the alkylating agents N-methyl-N-nitrosourethane (MNUT) and β-propioactone (BPL) were quantitatively measured in human lymphoblasts and Salmonella typhimurium. Forward mutation to 6-thioguanine resistance was measured in the human lymphoblasts, and forward mutation to 8-azaguanine resistance was measured in the bacterial cells after equigenerational (1.5 doubling times) exposures. In both systems, the induced mutant fraction rose linearly as a function of concentration for BPL and was biphasic for MNUT. The responses of the two assay systems to eight alkylating agents were compared. The exposure of the cells to each alkylating agent was calculated as exposure concentration multiplied by the time of exposure, and allowance was made for the decomposition of the alkylating agents during exposure (integral exposure). Human cells were 2.5 to 13 times more sensitive than was S. typhimurium to the alkylating agents methyl methanesulfonate, ethyl methanesulfonate, propyl methanesulfonate, N-methyl-N'-nitro-N-nitrosoguanidine, methylnitrosourea, and MNUT.

S. typhimurium cells were three times more sensitive to butyl methanesulfonate and 25 times more sensitive to BPL than were human cells.

HEALTH AND SAFETY

31242 (SAND—80-1621) **Special Projects Division quarterly report of progress, 1 April-30 June 1980.** (Sandia National Labs., Albuquerque, NM (USA)). Jul 1980. Contract AC04-76DP00789. 29p. NTIS, PC A03/MF A01.

Draft versions of three additional guidelines documents, designed to facilitate implementation of Environment, Safety, and Health (ES and H) Assurance Programs, were completed this quarter. These include Corporate Emergency Response Program (A Model), ES and H Staff Audit/Appraisal Programs, and Line Organization Internal ES and H Audit/Appraisal Guidelines. In addition, a partial draft of ES and H Assurance Program Information System Guidelines was prepared. This quarter saw the completion of the conceptual design of the ES and H assurance program information system, the identification of a detailed set of information system functions formed into 12 modules or computer program packages, and the initiation of computer programming on these 12 modules. Considerable effort was expended on the subject of safety analysis. A proposed guideline document for OES use was critiqued, and a different approach suggested.

GEOSCIENCES

GEOLOGY AND HYDROLOGY

REFER ALSO TO CITATION(S) 30297, 30300, 30307, 30308, 30317

31243 (CONF-8005101—1) **Interstitial water transport model in aquifer systems by finite element method.** Yeh, G.T. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 18p. NTIS, PC A02/MF A01.

From International conference on water resources development; Taipei, Taiwan (12 May 1980).

A finite element method is described for the solution of the Richards' equation governing the groundwater flow in variably saturated porous media. The dependent vairable, the pressure head, is approximated over each isoparametric element using mixed linear, quadratic, and cubic base functions. This approximation reduces the problem to a set of matrix equations whose term associated with the temporal derivative is the mass matrix. The lumping of the mass matrix together with the application of explicit time integration schemes produces an efficient method of solution. Because of the elliptic nature of the Richards' equation in spatial dimensions, the method is very likely to yield a conditionally stable and convergent solution. Because of this property, the requirement of large computer storage for the multidimensional problem is alleviated. The model is first tested by comparing its simulation with an exact solution for a simplified case. It is then compared favorably with the experimental data. The versatility of the model is demonstrated by applying it to a hypothetical aquifer to derive the direct surface runoff, base runoff, and aquifer storage accumulation following a three-hour storm.

31244 (IS-T—879) **Glacial geology of the West Tensleep Drainage Basin, Bighorn Mountains, Wyoming.** Burggraf, G.B. (Ames Lab., IA (USA)). Aug 1980. Contract W-7405-ENG-48. 96p. NTIS, PC A05/MF A01.

Thesis.

The glacial deposits of the West Tensleep Basin in the Bighorn Mountains of Wyoming are mapped and a relative chromology established. The deposits are correlated with the regional model as defined in the Wind River Mountains. A statistical analysis is performed on the density and weathering characteristics of the surficial boulders to determine their validity as indicators of relative age. (ACR)

GEOPHYSICS

SEISMOLOGY AND TECTONICS

REFER ALSO TO CITATION(S) 30298

31245 (UCRL—15260) **Seismic hazard analysis for the NTS spent reactor fuel test site.** Campbell, K.W. (TERA Corp., Berkeley, CA (USA)). 2 May 1980. Contract W-7405-ENG-48. 63p. NTIS, PC A04/MF A01.

An experiment is being directed at the Nevada Test Site to test the feasibility for storage of spent fuel from nuclear reactors in geologic media. As part of this project, an analysis of the earthquake hazard was prepared. This report presents the results of this seismic hazard assessment. Two distinct components of the seismic hazard were addressed: vibratory ground motion and surface displacement. (ACR)

GEOPHYSICAL SURVEY METHODS

31246 (UCID—18586) **Laboratory measurements of differential stress using acoustic double refraction.** Costantino, M.S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Mar 1980. Contract W-7405-ENG-48. 44p. NTIS, PC A03/MF A01.

This interim report describes the progress made in the period October 1, 1979-February 29, 1980 in evaluating Acoustic Double Refraction (ADR) as a diagnostic of in situ stress. It includes the definition of the project, a literature review, a brief discussion of the theoretical basis of the ADR effect, and an account of the hardware and software used to make the measurements. Aside from two, small, utility computer programs, the laboratory experiment is ready for its first test of signal acquisition and analysis.

31247 **Magnetotelluric data analysis: removal of bias.** Goubau, W.M.; Gamble, T.D.; Clarke, J. (Univ. of California, Berkeley). *Geophysics;* **43**: No. 6, 1157-1166(Oct 1978).

Two new techniques for analyzing 4-channel magnetotelluric (MT) data are described. These techniques produce estimates of the elements Z/sub y/ of the impedance tensor that are unbiased by noise in the autopowers of the electric and magnetic fields. Effectively, each technique uses one field channel as a reference signal that can be correlated with the other three channels. Method 1 obtains estimates for the Z/sub i;/ in terms of crosspowers of the Fourier components of the electric and magnetic fields E/sub x/(Ω), E/sub y/(Ω), H/sub x/(Ω), and H/sub y/(Ω). Method 2 is a generalization of method 1, and obtains estimates for Z/sub ij/ in terms of weighted crosspowers. Both methods fail when the geology is one-dimensional, or two-dimensional with one electrode oriented along the strike direction. To obtain results that are stable for any geology and that are unbiasd by autopower noise, at least five channels of data are required. To also minimize biase by correlated noises, one needs six channels of data, two channels of which are for fields measured at a site that is remote from the base MT station. The analysis of MT data using a remote magnetometer as a reference is discussed.

MINERALOGY, PETROLOGY, AND ROCK MECHANICS

REFER ALSO TO CITATION(S) 30213, 30301, 30302, 30303, 30304, 30306, 30316, 31151

31248 (DOE/ER/04054—4) **Fluid transport properties of rock fractures at high pressure and temperature. Progress report, July 1, 1979-June 30, 1980.** Engelder, T.; Scholz, C. (Columbia Univ., Palisades, NY (USA). Lamont-Doherty Geological Observatory). Apr 1980. Contract AS02-76-ER04504. 21p. NTIS, PC A02/MF A01.

Flow rates and thus permeability were measured for a variety of effective pressures on artificially prepared joints in Cheshire quartzite. Permeabilities calculated from constant head tests compare with permeabilities calculated from pulse decay tests. Measurement of the change in aperture with effective pressure shows that at effective pressures of less than 20 MPa changes in confining pressure have a larger influence on the aperture than changes in pore pressure. Joint permeability changes with aperture; thus changes in confining pressure are more influential on permeability than changes in pore pressure. Although a cubic law model for flow along a joint gives a rough estimate of joint permeability, measurements of the changes in flow rate with aperture suggest that the cubic law is inadequate for smooth joints at high pressure. This is so because the effective cross section available for flow changes with pressure in a nonlinear manner.

31249 (UCRL—84515) **Inelastic processes in seismic wave generation by underground explosions.** Rodean, H.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Aug 1980. Contract W-7405-ENG-48. 94p. NTIS, PC A05/MF A01.

Theories, computer calculations, and measurements of spherical stress waves from explosions are described and compared, with emphasis on the transition from inelastic to almost-elastic relations between stress and strain. Two aspects of nonspherical explosion geometry are considered: tectonic strain release and surface spall. Tectonic strain release affects the generation of surface waves; spall

closure may also. The reduced-displacement potential is a common solution (the equivalent elastic source) of the forward and inverse problems, assuming a spherical source. Measured reduced-displacement potentials are compared with potentials calculated as solutions of the direct and inverse problems; there are significant differences between the results of the two types of calculations and between calculations and measurements. The simple spherical model of an explosion is not sufficient to account for observations of explosions over wide ranges of depth and yield. The explosion environment can have a large effect on explosion detection and yield estimation. The best sets of seismic observations for use in developing discrimination techniques are for high-magnitude high-yield explosions; the identification problem is most difficult for low-magnitude low-yield explosions. Most of the presently available explosion data (time, medium, depth, yield, etc.) are for explosions in a few media at the Nevada Test Site; some key questions concerning magnitude vs yield and m/sub b/ vs M/sub s/ relations can be answered only by data for explosions in other media at other locations.

GEOCHEMISTRY

REFER ALSO TO CITATION(S) 30205, 30206, 30226, 30227, 30229, 30315

31250 (DOE/EV/00890—T1) **Trace element geochemistry of the South Atlantic Bight. Progress report.** Windom, H.L.; Wallace, G.T. (Skidaway Inst. of Oceanography, Savannah, GA (USA)). Mar 1980. Contract AS09-76EV00890. 100p. NTIS, PC A05/MF A01.

This report summarizes research conducted during the past year under DOE Contract EY-76-S-09-0890. During this time, studies have been continued in the mid to outer continental shelf region. We have also initiated nearshore studies designed to elucidate processes influencing the fate of trace elements in estuaries and the coastal frontal zone. A smaller effort has been concerned with preliminary geochemical studies of uranium-thorium natural decay series radionuclides and with improvement, calibration, and expansion of our trace element laboratory procedures.

31251 (LA—8382-MS) **Compilation of elemental concentration data for fourteen Canadian Certified Reference Materials Project Standards.** Gladney, E.S. (Los Alamos Scientific Lab., NM (USA)). May 1980. Contract W-7405-ENG-36. 33p. NTIS, PC A03/MF A01.

Elemental composition data on MRG-1, SY-2, SY-3, SO-1 → SO-4, DH-1, DL-1, and BL-1 → BL-5 have been collected from the open literature and certifying agency publications. Where possible, these data are summarized into mean values with standard deviations. All individual data, their uncertainties, and specific references are reported.

OCEANOGRAPHY

31252 (DOE/SR/01025—T2) **Nearshore transport processes affecting dilution and fate of energy-related contaminants. Final report, 8 August 1977-30 September 1979.** Blanton, J.O. (Skidaway Inst. of Oceanography, Savannah, GA (USA)). 1979. Contract AS09-77SR01025. 263p. NTIS, PC A12/MF A01.

This report summarizes the findings and work completed under contract DE-AS09-77SR01025-3. The principal efforts consisted of (1) editing, analysis and plotting of oceanographic data obtained at the Savannah River Navigational Light Tower (SNLT), (2) the synthesis of data from a pilot experiment on transport of trace elements, and (3) the planning of an autumn 1979 experiment. The final report is organized into products that show what was done on these three tasks plus additional smaller tasks specified in Appendix A of the contract. Data are presented from the following specific subject areas: (1) oceanographic and meteorologial data 15 km off the coast of Georgia; (2) oceanographic and meteorological data from Savannah Navigational Light Tower: 9-11 May 1978 Experiment; (3) data report on sea level fluctuations in the South Atlantic Bight; (4) oceanographic and meteorological data 15 km off the coast of Georgia.

PHYSICS RESEARCH

ASTROPHYSICS AND COSMOLOGY

31253 **Particle acceleration mechanisms in astrophysics.** Arons, J.; Max, C.; McKee, C. (eds.). New York, NY; American Institute of Physics (1979). 440p. (CONF-790144—).

From Workshop on particle accleration mechanisms in astrophysics; La Jolla, CA, USA (3 Jan 1979).

Individual papers were abstracted separately for the data base.

COSMIC RADIATION

31254 **Polarization of the primeval radiation in an anisotropic universe.** Negroponte, J.; Silk, J. (Department of Physics, University of California, Berkeley, California 94720). *Phys. Rev. Lett.;* **44**: No. 21, 1433-1437(26 May 1980).

The results are given of accurate computations of the polarization of the cosmic microwave background radiation in homogeneous anisotropic universes with flat space-like hypersurfaces. The degree of polarization never exceeds the maximum temperature quadrupole anisotropy, and its value is found to be very sensitive both to the mass fraction in the form of hydrogen and its ionization history. There is no spectral distortion to first order.

31255 **Gamma-ray astronomy.** Matteson, J.L. (Univ. of California, San Diego). *Trans. Am. Nucl. Soc.;* **33**: 220-221(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

STARS

REFER ALSO TO CITATION(S) 31258

QUASI-STELLAR, RADIO, AND X-RAY SOURCES

31256 **Recent progress in x-ray and gamma-ray astrophysics.** Gorenstein, P. (Harvard/Smithsonian Center for Astrophysics, Cambridge, MA). *Trans. Am. Nucl. Soc.;* **33**: 218(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

SOLAR PHENOMENA

31257 (INIS-mf—5325, pp 70-75) **Helium(3) rich solar flares.** Colgate, S.A. (Los Alamos Scientific Lab., NM (USA)); Audouze, J. (Paris-11 Univ., 91 - Orsay (France). Centre de Spectrometrie Nucleaire et de Spectrometrie de Masse); Fowler, W.A. (California Inst. of Tech., Pasadena (USA). W.M. Keck Lab. of Engineering Materials). Aug 1977.

From International cosmic ray conference; Plovdiv, Bulgaria (13 Aug 1977).

We interpret the extreme enrichment of $^3He/^4He > = 1$ in some solar flares as due to spallation and the subsequent confinement of the products in a high temperature, kT - tilde 200 keV, high density, nsub(e) - tilde 3×10^{15} cm^{-3} plasma associated with the magnetic instability producing the flare. The pinch or filament is a current of high energy protons that creates the spallation and maintains the temperature that produces the high energy x-ray spectrum and depletes other isotopes D, Li, Be, and B as observed. Finally the high temperature plasma is a uniquely efficient spallation target that is powered by the interaction of stellar convection and self generated magnetic field.

GALAXIES

31258 **Luminosity functions of disk and halo populations in SA 51, SA 57, and SA 68.** Chiu, L.G. (Department of Astronomy, University of California at Berkeley, Berkeley, California 94720). *Astron. J.;* **85**: No. 7, 812-823(Jul 1980).

An investigation of the luminosity functions of Population I main- sequence stars, Population I white dwarfs, and Population II subdwarfs in SA 51, SA 57, and SA 68 is made using the V'/V'/sub m/ method. The luminosity function of Population I main-sequence stars in my sample depends on the scale height z_0 adopted. The permissible range of z_0, using the V'/V'/sub m/ test, is 300—500 pc. From kinematic considerations, it is argued that the appropriate z_0 for the present sample is 500 pc. The space density of Population I white dwarfs is estimated to be 2×10^{-2} pc^{-3}. The scale height for Population I white dwarfs is 400—500 pc. The local mass density of Population II objects is estimated to be 3×10^{-4} M/sub sun/ pc^{-3}.

COSMOLOGY

31259 (SLAC-Trans—0192) **Cosmological models of the universe with rotation of time's arrow.** Sakharov, A.D. (AN SSSR, Moscow. Fizicheskij Inst.). May 1980. Translation source information not available . 12p. NTIS, PC A02/MF A01.

The paper treats cosmological models of the universe with rotation of time's arrow. The hypothesis of cosmological CPT symmetry previously advanced by the author and the hypothesis of a many-sheeted open model with negative space curvature and an invariant combined charge are presented. The statistical paradox of the reversibility and baryon asymmetry of the universe is discussed

with respect to these models. The fundamental possibility of estimating (in absolute magnitude) the serial number of the expansion-contraction cycle corresponding to the present stage of evolution of the universe is pointed out for the many-sheeted model with rotation of time's arrow. The small dimensionless quantity $10^{-58} = \delta^2/\alpha^2$ (where α is the hyperbolic radius and δ^{-3} the entropy density), which characterizes the average space curvature of the universe, is explained as a result of the evolution of the universe in the course of many successive expansion-contraction cycles.

PLANETARY PHENOMENA

31260 (CONF-800361—2) **Refractory metal particles in refractory inclusions in the Allende meteorite.** Fuchs, L.H.; Blander, M. (Argonne National Lab., IL (USA)). 1980. Contract W-31-109-ENG-38. 30p. NTIS, PC A03/MF A01.

From 11. lunar and planetary science conference; Houston, TX, USA (Mar 1980).

An examination of refractory metal particles in five calcium-aluminum-rich inclusions in the Allende meteorite indicates a complex variety of compositions and large departures from equilibrium. These particles appear to have been primordial condensates which were isolated from the nebula and from each other at different times by cocondensing oxides. Selective diffusion and/or oxidation of the more oxidizable metals (Mo, W, Fe and Ni), phase segregations into different alloy phases (fcc, bcc, hcp and perhaps ordered phases) and the formation of metastable condensates appears to have been involved in the modification of these materials to their present state. Only a small fraction of our observations cannot be reconciled with this picture because of a lack of knowledge of some of the phase equilibria which might have bee involved.

31261 **Solar system studies through remote sensing nuclear techniques.** Trombka, J.I. (NASA, Greenbelt, MD); Metzer, A.E. *Trans. Am. Nucl. Soc.;* **33**: 218-219(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31262 **Techniques for future planetary exploration.** Clark, B.C. (Martin Marietta Aerospace, Denver, CO). *Trans. Am. Nucl. Soc.;* **33**: 221(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

ATMOSPHERIC PHYSICS

AURORAL AND IONOSPHERIC PHENOMENA

31263 (PPPL—1681) **Numerical simulations on ion acoustic double layers.** Sato, T.; Okuda, H. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Jul 1980. Contract AM02-76CH03073. 34p. NTIS, PC A03/MF A01.

A comprehensive numerical study of ion acoustic double layers has been performed for both periodic as well as for nonperiodic systems by means of one-dimensional particle simulations. For a nonperiodic system, an external battery and a resistance are used to model the magnetospheric convection potential and the ionospheric Pedersen resistance. It is found that the number of double layers and the associated potential buildup across the system increases with the system length.

ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS

REFER ALSO TO CITATION(S) 31320

31264 (LBL—10813) **Ground state of the electron gas by a stochastic method.** Ceperley, D.M.; Alder, B.J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.; California Univ., Livermore (USA). Lawrence Livermore Lab.). May 1980. Contract W-7405-ENG-48. 18p. NTIS, PC A02/MF A01.

An exact stochastic simulation of the Schroedinger equation for charged Bosons and Fermions was used to calculate the correlation energies, to locate the transitions to their respective crystal phases at zero temperature within 10%, and to establish the stability at intermediate densities of a ferromagnetic fluid of electrons.

BEAMS AND THEIR REACTIONS

REFER ALSO TO CITATION(S) 30381

31265 **Systematics of target and projectile K-x-ray production and radiative electron capture for 20—80-MeV Cl/sup q/+ ions incident on 25—200-μg/cm² Cu targets.** Tanis, J.A.; Jacobs, W.W.; Shafroth, S.M. (Department of Physics and Astronomy, University of North Carolina, Chapel Hill, North Carolina 27514). *Phys. Rev., A;* **22**: No. 2, 483-495(Aug 1980).

A systematic investigation of K-x-ray production for 20 —80-MeV Cl ions in collision with thin self-supporting Cu targets has been conducted. Target and projectile characteristic x rays and radiative electron capture (REC) have been measured as a function of target thickness for incident charge states $q<Z_1$-2. At 80 MeV data were also obtained for $q=Z_1$-1. Large enhancements in both characteristic x-ray production and REC were observed for $q=Z_1$-1. Measured x-ray yields were parametrized versus target thickness using the model of Betz et al., and least-squares fits to the data were performed. Target K-x-ray production for $q<Z_1$-2 is described reasonably well by the Coulomb perturbed-stationary-state relativistic plus electron capture relativistic (CPSSR+ECR) theory. For $q=Z_1$-1 the enhancement in the x-ray yield is predicted quite well by the method of Gray et al. The mean fluorescence yield for the highly stripped Cl ions is determined and found to increase by a factor of about 6 over the range 20 —80 MeV, having a value ($\sim$ 0.1) nearly equal to the single K-vacancy value at 20 MeV. The radiative lifetime for the projectile ions is found to be $\sim 3 \times 10^{-14}$ sec, which is about three times longer than the single-K-vacancy radiative lifetime calculated by Scofield. Parametrization of the REC yields versus target thickness is used to normalize the measured REC intensity to the fraction of ions with K vacancies. Resulting REC cross sections are compared with the free-electron theory of Bethe and Salpeter and good agreement is obtained if it is assumed that each of the "loosely" bound electrons in Cu contributes equally to the REC process. By combining the results obtained for the characteristic x rays and REC, the fluorescence yield for K-shell capture events may be estimated, giving values in the range $(2— 4) \times 10^{-3}$ for the beam energies studied.

31266 **Defect production and electronic stopping for light ions in metals.** Averback, R.S.; Benedek, R.; Merkle, K.L.; Thompson, L.J. (Argonne National Lab., IL (USA). Materials Science Div.). *J. Nucl. Mater.;* **85**: No. 86, 503-507(Dec 1979).

From 1. topical meeting on fusion reactor materials; Miami Beach, FL (29 - 31 Jan 1979).

A method for determining effective electronic stopping powers in metals is presented. The method involves measuring damage rates in thin films as a function of ion energy. The experimental results are compared with predictions based on Monte Carlo computer simulations. Results are presented for H, D, He, and Li projectiles on Cu, Ag, and Ni. The implication of these results for defect production is discussed.

COLLISION PHENOMENA

31267 (LBL—10616) **Negative ion production by backscattering from alkali-metal surfaces bombarded by ions of hydrogen and deuterium.** Schneider, P.J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1980. Contract W-7405-ENG-48. 142p. NTIS, PC A07/MF A01.

Thesis.

Measurements have been made of the total backscattered D^- and H^- yields from thick, clean targets of Cs, Rb, K, Na, and Li, bombarded with H_2^+, H_3^+, D_2^+, and D_3^+ with incident energies from 0.15 to 4.0 keV/nucleus. All of the measurements were made at background pressures less than 10^{-9} Torr and the alkali-metal targets were evaporated onto a cold substrate (T = 77K) in situ to assure thick, uncontaminated targets. Measurements of the H^- yield from various transition metal targets with thin coverages of alkali-metals have also been made as a function of the surface work function. The negative ion yields are discussed in terms of the probabilities of reflection of the incident particles, of formation of the negative ion at the surface and of the survival of the negative ion leaving the surface. For each thick alkali-metal target, the negative ion yield measurements have been used in a least squares fit to determine two parameters in a theoretically derived expression for the negative ion yield. The parameters obtained from a thick Na target have been used to calculate the yield from a Cu target with thin coverage of Na (such that the surface work function is equal to thick Na).

31268 **Electron capture by heavy multicharged ions from atomic hydrogen at low velocities.** Crandall, D.H.; Phaneuf, R.A.; Meyer, F.W. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., A;* **22**: No. 2, 379-387(Aug 1980).

Total cross sections for capture of an electron by Xe/sup q/+ (2 < or = q < or = 12), Ar /sup q/+ (2 < or = q < or = 9), and Fe/sup q/+ (q=5,6) colliding with atomic and molecular hydrogen have been measured for velocities between 10^7 and 10^8 cm/s. The cross sections vary from below 1×10^{-16} cm² to just above 100×10^{-16} cm², with the measured values for q > or = 4 all greater than 37×10^{-16} cm². The cross sections are independent of ionic species for a given q and are generally constant with changing velocity. The cross sections increase linearly with q up to q=9, but for the highest-charge states q=9—12, the data suggest that the

cross sections do not continue to increase as rapidly with increasing q.

31269 Total electron detachment cross sections for collisions of negative halogen ions with various molecules for energies around threshold. Doverspike, L.D.; Smith, B.T.; Champion, R.L. (Department of Physics, College of William and Mary, Williamsburg, Virginia 23185). *Phys. Rev., A;* **22**: No. 2, 393-398(Aug 1980).

Absolute total electron detachment cross sections for collisions of Cl^- and Br^- with the molecular targets H_2, D_2, O_2, N_2, CO, CO_2, and CH_4 are presented. In each case, the experimental studies extend from collision energies below the threshold for detachment up to several hundred eV. All systems show detachment thresholds which exceed the electron affinity of the halogen atom involved. Detachment rate constants determined from the measured detachment cross sections are included.

FLUID PHYSICS

SUPERFLUIDITY

31270 Measurement of local disorder in a two-dimensional electron fluid. Lambert, D.K.; Richards, P.L. (Department of Physics, University of California, Berkeley, California 94720). W-7405-ENG-48. *Phys. Rev. Lett.;* **44**: No. 21, 1427-1429(26 May 1980).

The first direct measurement of local disorder in the relative positions of electrons on the surface of liquid helium is reported. The disorder is measured using the change in the transition frequency between one-electron bound states caused by the dipole electric field of nearby surface electrons. The measured value is in agreement with published theoretical predictions.

HIGH ENERGY PHYSICS

31271 (DOE/ER/03230—T1) **Research in elementary particle physics. Technical progress report, May 1, 1979-May 29, 1980.** Kirsch, L.E.; Schnitzer, H.J. (Brandeis Univ., Waltham, MA (USA). Dept. of Physics). 1980. Contract AS02-76ER03230. 15p. NTIS, PC A02/MF A01.

Experimental research during the period involved use of the BNL multiparticle spectrometer to study S=-2 production and charm and baryonium production. Comments on the program are offered, along with a brief discussion of work on particle detectors. Theoretical research concentrated on topics in effective field theories, quantum chromodynamics, supersymmetry, and Regge behavior in gauge theories. This report is administrative in nature, with no data. A publications list is included. (RWR)

PARTICLE INTERACTIONS AND PROPERTIES - EXPERIMENTAL

31272 (COO—1195-453) **Annual progress report.** Wattenberg, A.; Simmons, R.O. (Illinois Univ., Urbana (USA). Dept. of Physics). Jun 1980. Contract AC02-76ER01195. 33p. NTIS, PC A03/MF A01.

During the present year, a major effort was put into developing the Mark III detector to be used with the e^+e^- colliding beams at SPEAR. Data from previous experiments at Fermilab using both neutral and charged particle beams were analyzed, and an approximately seven-month run with the photon beam on hydrogen and deuterium targets was performed. Apparatus for the forthcoming series of experiments using a proton beam with the Chicago Cyclotron Facility at Fermilab was developed and built. The main motivation for all the above experiments was to study the production and decay of states containing charmed quarks. During the coming year a major effort will continue at SLAC with the completion of the Mark III detector and its use in taking initial data. It is anticipated that several years of data taking with the Mark III will be required to obtain a statistically significant number of events of interest. At Fermilab an experiment using a proton beam with the Chicago Cyclotron Facility and a neutron beam in the broad band neutral beam facility will be performed. The data from the previous photoproduction run will be analyzed. In future years at Fermilab, experiments will be performed at increasingly higher energies as they become available. One of the motivations is the possible production of the (weak) intermediate vector bosons by colliding proton and anti-proton beams. For this purpose, a detector for the colliding beams is being developed, as is the so-called FASTBUS system. The scope of the program is best summarized by listing major accomplishments during the present year and the major parts of the program for the coming year. Being administrative in nature, this report contains insignificant amounts of data. (RWR)

ELECTROMAGNETIC INTERACTIONS

31273 High-energy photoproduction of the D^{*+}. Avery, P.; Wiss, J.; Butler, J.; Gladding, G.; Goodman, M.C.; O'Halloran, T.; Russell, J.J.; Wattenberg, A.; Binkley, M.; Cumalat, J.; Gaines, I.; Gormley, M.; Loveless, R.L.; Peoples, J.; Atiya, M.S.; Holmes, S.D.; Knapp, B.C.; Lee, W.; Wisniewski, W.J. (University of Illinois, Urbana, Illinois 61801). *Phys. Rev. Lett.;* **44**: No. 20, 1309-1312(19 May 1980).

Photoproduction of the D^{*+} have been observed where the D^{*+} decays via $D^{*+} \rightarrow \pi^+ D^0$ and the D^0 decays via $K^-\pi^+$ and K/sub s/$\pi^+\pi^-$. The D^{*+}, D^0 mass difference and the D^0 mass observed here are in excellent agreement with previous measurements of charmed mesons produced in e^+e^- annihilations. The photoproduced D^{*+} and D^{*-} signals are produced nearly equally at the level of about 100 nb/nucleon.

STRONG BARYON-INDUCED INTERACTIONS

31274 (LA—8377-T) Measurement of the doubly differential cross section for $\pi^-p \rightarrow \pi^+\pi^-n$ near threshold. Walter, J.B. (Los Alamos Scientific Lab., NM (USA)). May 1980. Contract W-7405-ENG-36; AS02-76ER02197. 131p. NTIS, PC A07/MF A01.

Thesis.

The doubly differential cross sections for the π^+ from the reaction $\pi^-p \rightarrow \pi^+\pi^-n$ were measured at about twenty points for each of five energies between 245 MeV and 356 MeV. The experiment was carried out at the Clinton P. Anderson Meson Physics Facility, where a double focusing magnetic spectrometer detected the π^+ mesons produced in a liquid hydrogen target. The measurements were normalized by comparison with π^-p elastic scattering measured with the same apparatus. These are the first such measurements in this energy range, and have an accuracy between 4.7% and 39%. The integrated reaction cross section was determined at each energy with an accuracy of about 5%. These agree with but are an improvement over previous measurements in this energy range. Comparison of the extrapolated threshold value of the mean square modulus of the matrix element with the soft pion calculations favors the symmetry breaking mechanism of Weinberg ($\xi = 0$). It also demonstrates the futility of attempting to determine the symmetry breaking parameter ξ from a single measurement of the integrated reaction cross section.

31275 Depolarization parameter in pp inclusive scattering at 6 GeV/c. Courant, H.; Kagan, H.; Makdisi, Y.; Marshak, M.L.; Peterson, E.A.; Ruddick, K.; Biegert, E.K.; Mulera, T.A.; Poole, R.; Roberts, J.B.; Klem, R. (School of Physics, University of Minnesota, Minneapolis, Minnesota 55455). *Phys. Rev. Lett.;* **44**: No. 21, 1373-1376(26 May 1980).

The depolarization parameter for pp inclusive scattering at an incident momentum of 6 GeV/c was measured. The D parameter for inclusive scattering indicates the dominance of natural-parity exchange at small t, except in the case of $N^*(1232)$ production, where π exchange is more important. D for elastic scattering has also been measured. This parameter shows a small decrease from unity with increasing momentum transfer.

31276 Limit on bottom-meson pair production in π^--nucleus interactions at 225 GeV/c. Coleman, R.N.; Anderson, K.J.; Karhi, K.P.; Newman, C.B.; Pilcher, J.E.; Rosenberg, E.I.; Thaler, J.J.; Hogan, G.E.; McDonald, K.T.; Sanders, G.H.; Smith, A.J.S. (Enrico Fermi Institute, University of Chicago, Chicago, Illinois 60637). *Phys. Rev. Lett.;* **44**: No. 20, 1313-1315(19 May 1980).

In an experiment to measure multimuon final states in interactions of 225-GeV/c π^- with nuclear targets we have observed 65 900 J/psi $\rightarrow \mu^+\mu^-$ decays, of which 487 are accompanied by a third muon. We have used this sample to search for production of bottom-meson pairs, followed by the decays B $\rightarrow$ J/psiX, B-bar $\rightarrow \mu$+X. We find, supposing linear A dependence, that σ(BB-bar)<8 nb/nucleon with 90% confidence. This limit is in contradiction with a recent report that σ(BB-bar) $\simeq$ 200 nb/nucleon.

PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL

GENERAL

REFER ALSO TO CITATION(S) 31282, 31283

31277 Unstable heavy particles. Frampton, P.H.; Glashow, S.L. (Lyman Laboratory of Physics, Harvard University, Cambridge, Massachusetts 02138). *Phys. Rev. Lett.;* **44**: No. 23, 1481-1483(9 Jun 1980).

It is pointed out that for very massive particles in our universe there exist stringent bounds on their possible properties. New experiments which will search primarily for proton decay can usefully extend the domain of these bounds.

31278 **Relativistic wave equation and mass spectrum of gluonium.** Suura, H. (School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455). EY-76-C-02-1764. *Phys. Rev. Lett.;* **44**: No. 20, 1319-1322(19 May 1980).

A relativistic wave equation is derived for gauge-invariant J=0 gluonium amplitudes, and show that its reduced eigenvalue equation is identical with that for a quark-antiquark system in $^3P_1$ states. Analysing relations between potentials in the two respective systems, I obtain an upper limit of 2 GeV to the ground-state mass if I take light quarkonium as a reference system, whereas I estimate the ground state to lie between 2.5 and 3 GeV if I use charmonium potential parameters. The scalar and the pseudoscalar gluonium states are degenerate in the present approach.

ELECTROMAGNETIC INTERACTIONS

REFER ALSO TO CITATION(S) 31285

WEAK INTERACTIONS

31279 (BNL—27699) **Kaon-nucleus interactions.** Dover, C.B. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract EY-76-C-02-0016. 40p. (CONF-800375—1). NTIS, PC A03/MF A01.

From Workshop on low and intermediate energy kaon-nucleon physics; Rome, Italy (24 Mar 1980).

The recent progress in hypernuclear physics, in particular the studies of Λ and Σ states via the strangeness-exchange (K^-,π^-) reaction, are reviewed. Prospects for future investigations with (proposed) intense kaon beams are also evaluated, for instance the production of high spin hypernuclei via the (π^+,K^+) reaction, and the formation of strangeness S = -2 hypernuclei ($\Lambda\Lambda$ or Xi^-) by means of the (K^-,K^+) process. A very brief resume of elastic, inelastic and charge exchange reactions induced by the interaction of K^+ mesons with nuclei is given.

31280 (LA-UR—80-1778) **Note on the decays $\pi^0 \rightarrow \nu\nu'$.** Herczeg, P.; Hoffman, C.M. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 11p. (CONF-800724—1). NTIS, PC A02/MF A01.

From 20. international conference on high energy physics; Madison, WI, USA (17 Jul 1980).

Phenomenological aspects of $\pi^0 \rightarrow \nu\nu'$ are considered. From the existing experimental information, an upper limit $\Gamma(\pi^0 \rightarrow \nu\nu')/\Gamma(\pi^0 \rightarrow \text{all}) < 2.4 \times 10^{-5}$ (90% C.L.) is deduced. Possible mechanisms which can give rise to this process are discussed. Branching ratios of the order of 10^{-7} for decays into the known neutrinos (ν/sub e/,ν/sub μ/) are found possible. Rates comparable to the experimental limit for decays into final states involving additional neutrinos (massive or massless) cannot be ruled out.)

STRONG INTERACTIONS, BARYON NO.=0

31281 **Static meson potentials.** Bolsterli, M. (T Division, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev., D;* **22**: No. 2, 437-442(15 Jul 1980).

The potentials between static sources of meson fields are computed for various cases of interest. For isoscalar mesons, the interaction via a scalar-meson field is the well-known Yukawa potential; the interaction via an isoscalar vector-meson field is shown to have the expected Yukawa form when an appropriate Hamiltonian is used. For isovector mesons, which interact through non-Abelian current operators, numerical computations of the potential are presented for vector-meson field interactions. In contrast to the Abelian cases, the non-Abelian interactions are not the same as the one-meson-exchange potentials.

PARTICLE INVARIANCE PRINCIPLES AND SYMMETRIES

GENERAL

31282 (SLAC-PUB—2499) **Symmetry breaking patterns for unitary and orthogonal groups.** Buccella, F.; Ruegg, H.; Savoy, C.A. (Rome Univ. (Italy). Ist. di Fisica; Stanford Linear Accelerator Center, CA (USA); Geneva Univ. (Switzerland); Strasbourg-1 Univ., 67 (France). Centre de Recherches Nucleaires). Apr 1980. Contract AC03-76SF00515. 15p. (CONF-800469—3). NTIS, PC A02/MF A01.

From 1. workshop on grand unification; Durham, NH, USA (10 Apr 1980).

The spontaneous symmetry breaking pattern for SU(n) and 0(10) is discussed. It is based on the exact treatment of the absolute minimum of the Higgs potential as a function of scalar fields belonging to the fundamental and adjoint representations of SU(n), the spinor and adjoint representations of 0(10). 2 tables.

APPLICATIONS TO STRONG INTERACTIONS

31283 (COO—3533-166) **Flavor unifying schemes with a single fermionic representation.** Davidson, A.; Wali, K.C. (Syracuse Univ., NY (USA). Dept. of Physics). May 1980. Contract AS02-76ER03533. 8p. (CONF-800724—4). NTIS, PC A02/MF A01.

From 20. international conference on high energy physics; Madison, WI, USA (17 Jul 1980).

If quarks and leptons are indeed elementary, it is natural that they belong to a single representation of a unifying group, G. It is shown that such a requirement, which is inconsistent with G = SU(N), can be satisfied within the semi-simple group G = SU(N) x SU(N). Furthermore, N = 7 emerges as the unique solution accompanied by a fermionic set that exhibits a natural generation structure.

FIELD THEORY

REFER ALSO TO CITATION(S) 31278, 31281

31284 **Dynamical breaking of chiral symmetry in lattice gauge theories.** Svetitsky, B.; Drell, S.D.; Quinn, H.R.; Weinstein, M. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). DE-AC03-76SF00515. *Phys. Rev., D;* **22**: No. 2, 490-504(15 Jul 1980).

We generalize the variational block-spin methods developed earlier to show that spontaneous breaking of chiral symmetries and the associated massless Goldstone particles arise naturally within the context of strong-coupling lattice gauge theory. Our calculations show the importance of preserving continuous chiral symmetry when transcribing the quantum chromodynamics (QCD) of massless quarks onto the lattice. The meson sector is analyzed for both one and three spatial dimensions, and the criteria for recognizing Nambu-Goldstone phenomena are identified. The relation of these results to continuum QCD and to general properties of observed hadrons is also discussed.

31285 **Effective Lagrangian due to heavy quarks in quantum chromodynamics.** Kazama, Y.; Yao, Y. (Fermi National Accelerator Laboratory, P.O. Box 500, Batavia, Illinois 60510). *Phys. Rev., D;* **22**: No. 2, 514-522(15 Jul 1980).

We extend our previous analysis of heavy-particle effects in the low-energy light-particle sector to quantum chromodynamics. The central technique is the use of the Ward-Takahashi identities due to Becchi-Rouet-Stora transformations. Some discussion of the isolation of mass singularities is given. An important result in our approach, as before, is to give precise meaning to the notion of an effective Lagrangian (which is renormalized) with calculable effective coupling constants. The counterterms for the effective local vertices in the Lagrangian are self-generated by the theory, while the effective coupling constants obey a set of Callan-Symanzik-type equations.

31286 (SLAC-Trans—0191) **Mass formula for mesons and baryons.** Sakharov, A.D. (AN SSSR, Moscow. Fizicheskij Inst.). May 1980. Translation source information not available . 13p. NTIS, PC A02/MF A01.

The number of independent parameters in the semiempirical formula suggested by Ya.B. Zel'dovich and the author is reduced by using chromodynamic considerations. The consequences are compared with experiments. A list of new predictions is given.

SCATTERING THEORY

31287 (SLAC-PUB—2515) **Minimal relativistic three particle equations.** Lindesay, J.V.; Noyes, H.P. (Stanford Linear Accelerator Center, CA (USA)). May 1980. Contract AC03-76SF00515. 4p. (CONF-800829—1). NTIS, PC A02/MF A01.

From International conference on the few body problems; Eugene, OR, USA (17 Aug 1980).

A relativistic, 3-particle equation with minimal 2-body input has unique solutions for bound states, and exhibits the Efimov effect (that there is an infinite accumulation of 3-particle bound states as the scattering length between the pairs increases without bound). The theory is Lorentz invariant and unitary. The physical input (for the three equal mass case) is in one parameter μ, the mass of the 2-body bound (or virtual) states. The Efimov effect for the nonrelativistic theory occurs for (absolute value a/R) $\rightarrow$ infinity, where a is the scattering length and R an effective range parameter, whereas in this theory the behavior is for $\mu \rightarrow 2m$, where m is the mass of any one of the three particles.

31288 **Resonances, scattering theory, and rigged Hilbert spaces.** Parravicini, G.; Gorini, V.; Sudarshan, E.C.G. (Department of Physics, Center for Particle Theory, The University of Texas at Austin,

Austin, Texas 78712). EY-76-S-05-3992. *J. Math. Phys. (N.Y.);* **21**: No. 8, 2208-2226(Aug 1980).

The problem of decaying states and resonances is examined within the framework of scattering theory in a rigged Hilbert space formalism. The stationary free, "in," and "out" eigenvectors of formal scattering theory, which have a rigorous setting in rigged Hilbert space, are considered to be analytic functions of the energy eigenvalue. The value of these analytic functions at any point of regularity, real or complex, is an eigenvector with eigenvalue equal to the position of the point. The poles of the eigenvector families give origin to other eigenvectors of the Hamiltonian: the singularities of the "out" eigenvector family are the same as those of the continued S matrix, so that resonances are seen as eigenvectors of the Hamiltonian with eigenvalue equal to their location in the complex energy plane. Cauchy theorem then provides for expansions in terms of "complete" sets of eigenvectors with complex eigenvalues of the Hamiltonian. Applying such expansions to the survival amplitude of a decaying state, one finds that resonances give discrete contributions with purely exponential time behavior; the background is of course present, but explicitly separated. The resolvent of the Hamiltonian, restricted to the nuclear space appearing in the rigged Hilbert space, can be continued across the absolutely continuous spectrum; the singularities of the continuation are the same as those of the "out" eigenvectors. The free, "in" and "out" eigenvectors with complex eigenvalues and those corresponding to resonances can be approximated by physical vectors in the Hilbert space, as plane waves can. The need for having some further physical information in addition to the specification of the total Hamiltonian is apparent in the proposed framework. The formalism is applied to the Lee—Friedrichs model and to the scattering of a spinless particle by a local central potential.

PHYSICS RESEARCH

REFER ALSO TO CITATION(S) 31446

NUCLEAR PHYSICS

REFER ALSO TO CITATION(S) 31320

31289 (LBL—11089) **Nuclear structure database.** Firestone, R.B.; Browne, E. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1980. Contract W-7405-ENG-48. 38p. NTIS, PC A03/MF A01.

A nuclear structure database has been created from the Table of Isotopes level-scheme file. This database contains evaluated data (through 1977) on level and deexcitation properties for all known isotopes from radioactive decay and nuclear reaction studies. The data are organized in simple array formats to enable rapid searches for specific level or decay information. Examples of the use of this database to study the properties of first excited J/sup π/ = 2^+ states in even-even nuclei and Weisskopf enhancements of delayed γ-ray transitions are shown. 6 figures, 3 tables.

EXPERIMENTAL TECHNIQUES

31290 (LA-UR—80-1643) **Analyzing-power formalism for three-body final states.** Ohlsen, G.G.; Brown, R.E.; Correll, F.D.; Hardekopf, R.A. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 4p. (CONF-800824—3). NTIS, PC A02/MF A01.

From 5. international symposium on polarization phenomena in nuclear physics; Santa Fe, NM, USA (11 Aug 1980).

Various relations important for extraction of analyzing powers from data on reactions involving three particles in the final state were derived. Several of the results pertinent for spin-1/2 and spin-1 polarized beams are presented here. These may be used in analysis of the ^{1}H(d-vector,pp)n reaction. 3 figures. (RWR)

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 31290

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

31291 (LA—8215-MS) **^{3}H(p,n)^{3}He differential cross sections below 5 MeV and the n-^{3}He cross sections.** Drosg, M. (Los Alamos Scientific Lab., NM (USA)). Jul 1980. Contract W-7405-ENG-36. 11p. NTIS, PC A02/MF A01.

Complete angular distributions for the ^{3}H(p,n)^{3}He reaction were measured at 2.5 and 4.0 MeV with the ^{1}H(t,n)^{3}He reaction used to obtain the backward yields. Because the distributions are peaked about 17% more strongly in the backward direction than the best previous elevation suggests (based on extrapolated data), the ^{3}H(p,n)^{3}He reaction cross sections below 5 MeV were re-evaluated without the extrapolated data. The results were compared with recent total n-^{3}He cross-section results. 3 figures, 4 tables.

31292 (LA-UR—80-1644) **Analyzing powers for the three-nucleon breakup reaction ^{1}H(d vector,p)pn at 16 MeV.** Brown, R.E.; Ohlsen, G.G.; Correll, F.D.; Hardekopf, R.A.; Jarmie, N. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 4p. (CONF-800824—7). NTIS, PC A02/MF A01.

From 5. international symposium on polarization phenomena in nuclear physics; Santa Fe, NM, USA (11 Aug 1980).

Analyzing powers for the ^{1}H(d,p)pn reaction were measured at 16.0 MeV and beam polarization of approximately 0.82. Similar data for the elastic scattering ^{1}H(d,p)^{2}H were also taken. The breakup analyzing power A/sub xz/, which attains the largest magnitude, is shown as a function of excitation energy. Angular distributions of elastic and breakup analyzing powers are compared; large differences are noted for A/sub xx/ and A/sub xz/. It is found that 1-MeV energy bins are too large to use in the study of singlet-state effects. 2 figures. (RWR)

31293 (LA-UR—80-1772) **Tensor analyzing powers in the ^{1}H(d vector,pp)n reaction at 16 MeV. I. The symmetric, constant-relative-energy configurations.** Correll, F.D.; Ohlsen, G.G.; Brown, R.E.; Hardekopf, R.A.; Jarmie, N.; Schwandt, P.; Doleschall, P. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 5p. (CONF-800824—4). NTIS, PC A02/MF A01.

From 5. international symposium on polarization phenomena in nuclear physics; Santa Fe, NM, USA (11 Aug 1980).

Experimental results for the tensor analyzing powers A/sub xx/ and A/sub yz/ in the ^{1}H(d-vector, pp)n reaction at 16 MeV for a series of symmetric, constant-relative-energy configurations are reported and compared with the results of recent Faddeev calculations using a separable NN potential. In general, the agreement seems fairly good, although there is some evidence that the measured values of A/sub yz/ tend to be slightly smaller than the prediction, whereas for A/sub xx/ the opposite appears to be true. 1 figure, 1 table. (RWR)

NUCLEAR PROPERTIES AND REACTIONS, A=6-19, EXPERIMENTAL

MASS, ABUNDANCE, AND BINDING ENERGY

REFER ALSO TO CITATION(S) 31294

NUCLEAR REACTIONS AND SCATTERING

31294 (COO—3244-76) **Gamow-Teller sum rules and the ^{14}C(^{6}Li,^{6}He)^{14}N reaction.** Wharton, W.R.; Goodman, C.D.; Hensley, D.C. (Carnegie-Mellon Univ., Pittsburgh, PA (USA); Oak Ridge National Lab., TN (USA)). 1977. Contract AS02-76ER03244. 22p. NTIS, PC A02/MF A01.

A correlation between the (^{6}Li,^{6}He) cross sections and the Gamow-Teller strength observed previously for other targets persists in the ^{14}C(^{6}Li,^{6}He) reaction. The total G.T. strength up to 12 MeV excitation is measured, and sum rules for the G.T. strength that depend on the LS configurations of the target state are derived. The extracted LS configuration of the ^{14}C ground state is in serious disagreement with shell model calculations. There are several inconsistencies within our understanding of the nuclear structure and transition strengths in these nuclei, part of which is attributable to mesonic currents. Constraints are also placed upon the (^{6}Li,^{6}He) reaction mechanism. 3 figures, 2 tables.

31295 (COO—3244-77) **(π^+,p) and (π^+,d) reactions on light nuclei.** Doss, K.G.R.; Barnes, P.D.; Colella, N.; Dytman, S.A.; Eisenstein, R.A.; Ellegaard, C.; Takeutchi, F.; Wharton, W.R.; Amann, J.F. (Carnegie-Mellon Univ., Pittsburgh, PA (USA); Los Alamos Scientific Lab., NM (USA)). [nd]. Contract AS02-76ER03244. 20p. NTIS, PC A02/MF A01.

The (π^+,p) and (π^+,d) reactions on 1p shell nuclei are studied between T/sub π/ = 32 and 81 MeV. The cross sections to both the continuum and discrete two-body final states are given. The spectra and angular distributions of the (π^+,p) continuum are interpreted in terms of a two-nucleon pion absorption mechanism. The ^{13}C(π^+,p) spectrum of discrete states is similar to the ^{13}C(p,d) spectrum at the same momentum transfer. The two-neutron-pickup (π,d) reaction is found to strongly favor transitions in the 1p shell of angular momentum transfer, L = 2. The relative strength of these transitions varies

the same way as the corresponding (p,t) cross sections. No L = 0 transitions are clearly identifiable. There is an indication of the S = 1 ^{7}Li(π^{+},d)^{6}Li(16.7 MeV) 3/2^{+} transition, contrary to the prediction that S = 1 transitions are suppressed. The (π^{+},d) angular distributions are compared to the calculations of Betz and Kerman. 2 tables.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 31306

NUCLEAR PROPERTIES AND REACTIONS, A=20-38, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

31296 (INIS-mf—5313, pp 67-71) **Experimental cross sections for the pickup of electrons by relativistic nuclei.** Raisbeck, G.M. (Paris-11 Univ., 91 - Orsay (France). Centre de Spectrometrie Nucleaire et de Spectrometrie de Masse); Crawford, H.J.; Lindstroem, P.J.; Greiner, D.E.; Beiser, F.S.; Heckman, H.H. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1977.

From International cosmic ray conference; Plovdiv, Bulgaria (13 Aug 1977).

Cross sections for the pickup of electrons in a variety of targets have been measured with beams of ^{12}C (150, 250, 400 MeV/n), ^{20}Ne (250, 400, 1050, 2100 MeV/n) and ^{40}Ar (400, 1050 MeV/n) from the Bevalac accelerator. The interpretation of the results in terms of radiative and non-radiative capture, and the implications for cosmic ray propagation studies are discussed.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 31306

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 31296

31297 **Limits to the fusion of 310-MeV ^{16}O with Ti.** Gonthier, P.; Ho, H.; Namboodiri, M.N.; Adler, L.; Natowitz, J.B.; Simon, S.; Hagel, K.; Terry, R.; Khodai, A. (Cyclotron Institute, Texas A&M University, College Station, Texas 77843). *Phys. Rev. Lett.;* **44**: No. 21, 1387-1391(26 May 1980).

Limits to the fusion of 310-MeV ^{16}O with Ti were probed using both singles and coincidence measurements of the heavy products and the emitted light particles. The upper limit to compound nucleus formation is found to be in accord with recent dynamic calculations, but the principal mechanism reducing the compound nucleus cross section below that predicted by critical distance models is not an increase in strongly damped processes, but the prompt emission of energetic light particles.

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 31303

NUCLEAR PROPERTIES AND REACTIONS, A=150-189, EXPERIMENTAL

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 31299

ENERGY LEVELS AND TRANSITIONS

31298 (CONF-800452—1) **High spin isomers in ^{153}Er.** Horn, D.; Young, G.R.; Lister, C.J.; Baktash, C. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract W-7405-ENG-26. 3p. NTIS, PC A02/MF A01.

From International conference on nuclear behavior at high angular momentum; Strassbourg, France (22 Apr 1980).

Energy levels of ^{153}Er were investigated with four NaI detectors in coincidence with a Ge(Li) detector. The existence of two long-lived high-spin isomers was confirmed, and their positions and decays were established. 1 figure. (RWR)

31299 **Nuclear data sheets for A=163.** Dairiki, J.M.; Browne, E.; Shirley, V.S. (Lawrence Berkeley Laboratory, Berkeley, California 94720, USA). W-7405-ENG-48. *Nucl. Data Sheets;* **29**: No. 4, 653-731(Apr 1980).

Nuclear structure data for all nuclei with mass number A=163 have been evaluated. Adopted values for level properties and detailed level and decay schemes are presented for each nucleus, along with the experimental data upon which they are based.

31300 (ORO—4936-5) **Nuclear spectroscopic studies. Progress report, June 1, 1979-May 31, 1980.** Bingham, C.R.; Riedinger, L.L.; Guidry, M.W. (Tennessee Univ., Knoxville (USA). Dept. of Physics and Astronomy). 1 Mar 1980. Contract EY-76-S-05-4936. 69p. NTIS, PC A04/MF A01.

Research conducted during the year ending May 31, 1980 is reported. Work is described in the following areas: radioactive decay studies, in-beam spectroscopy of high-spin states, inelastic scattering and reactions of heavy ions from deformed nuclei, and alpha decay of high-spin short-lived isomers. Particularly significant results were obtained on the band structure of light Yb nuclei. Activities relating to facilities development and administrative matters are also included, along with lists of references and publications. 14 figures. (RWR)

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

31301 (LA-UR—80-1645) **$^{194\ 196\ 198}$Pt(t,α)$^{193\ 195\ 197}$Ir reactions with polarized tritons.** Cizewski, J.A.; Flynn, E.R.; Sunier, J.W.; Brown, R.E.; Burke, D.G. (Los Alamos Scientific Lab., NM (USA); McMaster Univ., Hamilton, Ontario (Canada)). 1980. Contract W-7405-ENG-36. 4p. (CONF-800824—8). NTIS, PC A02/MF A01.

From 5. international symposium on polarization phenomena in nuclear physics; Santa Fe, NM, USA (11 Aug 1980).

The $^{194\ 196\ 198}$Pt(t vector, α)$^{193\ 195\ 197}$Ir reactions were measured. Angular distributions of cross sections and analyzing powers for levels up to $\sim$ 2.5 MeV in each residual nuclide were obtained, and comparisons with DWBA predictions allowed spins, parities, and pickup spectroscopic strengths to be determined. The results are being analyzed with the aim of testing the existence of supersymmetric structures in nature. 2 figures.

31302 (LA-UR—80-1926) **Core-coupled states excited in the ^{208}Pb(d vector,t)^{207}Pb reaction.** Sugarbaker, E.; Alford, W.P.; Boyd, R.N.; Cameron, J.; Flynn, E.; Sunier, J. (Colorado Univ., Boulder (USA); Western Ontario Univ., London (Canada); Ohio State Univ., Columbus (USA); McMaster Univ., Hamilton, Ontario (Canada); Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 4p. (CONF-800824—11). NTIS, PC A02/MF A01.

From 5. international symposium on polarization phenomena in nuclear physics; Santa Fe, NM, USA (11 Aug 1980).

A study of known core-excited states in ^{207}Pb shows that the cross section and analyzing power data are not well reproduced by two-step mechanisms. 3 figures.

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, THEORETICAL

SPONTANEOUS AND INDUCED FISSION

31303 (LA—8277-MS) **FITPULS: a code for obtaining analytic fits to aggregate fission-product decay-energy spectra.** LaBauve, R.J.; George, D.C.; England, T.R. (Los Alamos Scientific Lab., NM (USA)). Mar 1980. Contract W-7405-ENG-36. 100p. NTIS, PC A05/MF A01.

The operation and input to the FITPULS code, recently updated to utilize interactive graphics, are described. The code is designed to retrieve data from a library containing aggregate fine-group spectra (150 energy groups) from fission products, collapse the data to few groups (up to 25), and fit the resulting spectra along the cooling time axis with a linear combination of exponential functions. Also given in this report are useful results for aggregate gamma and beta spectra from the decay of fission products released from ^{235}U irradiated with a pulse (10^{-4} s irradiation time) of thermal neutrons. These fits are given in 22 energy groups that are the first 22 groups of the LASL 25-group decay-energy group structure, and the data are expressed both as MeV per fission second and particles per fission second; these pulse functions are readily folded into finite fission histories. 65 figures, 11 tables.

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

31304 (CONF-800743—4) **Actinide cross section program at ORELA.** Dabbs, J.W.T. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 21p. NTIS, PC A02/MF A01.

From International conference on nuclear waste transmutation; Austin, TX, USA (22 Jul 1980).

The actinide cross section program at ORELA, the Oak Ridge Electron Linear Accelerator, is aimed at obtaining accurate neutron cross sections (primarily fission, capture, and total) for actinide nuclides which occur in fission reactors. Such cross sections, measured as a function of neutron energy over as wide a range of energies as feasible, comprise a data base that permits calculated predictions of the formation and removal of these nuclides in reactors. The present program is funded by the Division of Basic Energy Sciences of DOE, and has components in several divisions at ORNL. For intensively α-active nuclides, many of the existing fission cross section data have been provided by underground explosions. New measurement techniques, developed at ORELA, now permit linac measurements on fissionable nuclides with alpha half-lives as short as 28 years. Capture and capture-plus-fission measurements utilize scintillation detectors (of capture γ rays and fission neutrons) in which pulse shape discrimination plays an important role. Total cross sections can be measured at ORELA on samples of only a few milligrams. A simultaneous program of chemical and isotopic analyses of samples irradiated in EBR-II is in progress to provide benchmarks for the existing differential measurements. These analyses are being studied with updated versions of ORIGEN and with sensitivity determinations. Calculations of the sensitivity to cross section changes of various aspects of the nuclear fuel cycle are also being made. Even in this relatively mature field, many cross sections still require improvements to provide an adequate data base. Examples of recent techniques and measurements are presented. 12 figures, 3 tables.

SPONTANEOUS AND INDUCED FISSION

REFER ALSO TO CITATION(S) 31304

NUCLEAR THEORY

NUCLEAR STRUCTURE

31305 (CONF-800213—13) **Some questions on the Coriolis force, the structure of rotational states and the IBM.** Khoo, T.L. (Argonne National Lab., IL (USA)). 1980. Contract W-31-109-ENG-38. 3p. NTIS, PC A02/MF A01.

From Band structure and nuclear dynamics conference; New Orleans, LA, USA (28 Feb 1980).

Participants in the Round Table Discussion at the International Conference on Band Structure and Nuclear Dynamics were to make editorial comments on what transpired during the conference. This paper contains comments of one panel member on questions which he feels were not addressed during the meeting. His comments concern the Coriolis force in rotating nuclei and its relation to the nucleon-nucleon interaction, the microscopic origin of rotational states, and the interacting boson model. (RWR)

31306 (DOE/ER/03069—783) **Level densities in nuclear physics.** Beckerman, M. (Massachusetts Inst. of Tech., Cambridge (USA). Lab. for Nuclear Science). 1978. Contract AC02-76ER03069. 31p. NTIS, PC A03/MF A01.

In the independent-particle model nucleons move independently in a central potential. There is a well-defined set of single-particle orbitals, each nucleon occupies one of these orbitals subject to Fermi statistics, and the total energy of the nucleus is equal to the sum of the energies of the individual nucleons. The basic question is the range of validity of this Fermi gas description and, in particular, the roles of the residual interactions and collective modes. A detailed examination of experimental level densities in light-mass system is given to provide some insight into these questions. Level densities over the first 10 MeV or so in excitation energy as deduced from neutron and proton resonances data and from spectra of low-lying bound levels are discussed. To exhibit some of the salient features of these data comparisons to independent-particle (shell) model calculations are presented. Shell structure is predicted to manifest itself through discontinuities in the single-particle level density at the Fermi energy and through variatons in the occupancy of the valence orbitals. These predictions are examined through combinatorial calculations performed with the Grover [Phys. Rev., 157, 832(1967), 185 1303(1969)] odometer method. Before the discussion of the experimenta results, statistical mechanical level densities for spherical nuclei are reviewed. After consideration of deformed nuclei, the conclusions resulting from this work are drawn. 7 figures, 3 tables. (RWR)

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 31290

31307 (LBL—10493) **Thermal and quantal isospin and spin fluctuations in heavy ion reactions.** Moretto, L.G. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jan 1980. Contract W-7405-ENG-48. 58p. (CONF-800139—1). NTIS, PC A04/MF A01.

From 18. international winter meeting on nuclear physics; Bormio, Italy (21 Jan 1980).

The isobaric charge distributions are discussed in terms of quantal and classical isospin fluctuations. The roles of mass asymmetry and of the higher giant isovector modes are treated within the framework of a cylinder model that is worked out exactly. Spin fluctuations are considered first in terms of quantal fluctuations in a cylinder model and second in terms of thermal fluctuations in a two-sphere model. The results are applied to the calculation of in- and out-of-plane angular distributions for sequential fission, alpha and gamma decay. Analytical expressions are obtained for the angular distributions. The theoretical predictions are compared with experimental results for sequential fission, alpha, and gamma angular distributions. 23 figures.

31308 (UCID—18737) **Optical model calculation of neutron-nucleus scattering cross sections.** Smith, M.E.; Camarda, H.S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 11 Jul 1980. Contract W-7405-ENG-48. 53p. NTIS, PC A04/MF A01.

A program to calculate the total, elastic, reaction, and differential cross section of a neutron interacting with a nucleus is described. The interaction between the neutron and the nucleus is represented by a spherically symmetric complex potential that includes spin-orbit coupling. This optical model problem is solved numerically, and is treated with the partial-wave formalism of scattering theory. The necessary scattering theory required to solve this problem is briefly stated. Then, the numerical methods used to integrate the Schroedinger equation, calculate derivatives, etc., are described, and the results of various programming tests performed are presented. Finally, the program is discussed from a user's point of view, and it is pointed out how and where the program (OPTICAL) can be changed to satisfy particular needs. (RWR)

31309 (COO—3244-75) **Mechanism of pion absorption in complex nuclei.** Doss, K.G.N.; Wharton, W.R. (Carnegie-Mellon Univ., Pittsburgh, PA (USA). Dept. of Physics). [nd]. Contract AS02-76ER03244. 12p. NTIS, PC A02/MF A01.

Basic geometrical arguments are used to analyze the A dependence of the total pion absorption cross section, the effective number of nucleons sharing the pion momentum and energy, and the proton yields from π^+- and π^--induced reactions. The results are consistent with the pions penetrating some distance through the nuclear volume and annihilating on a pair of nucleons. 3 figures.

NUCLEAR MODELS

REFER ALSO TO CITATION(S) 31305, 31306, 31308

RADIATION AND SHIELDING PHYSICS

RADIATION PHYSICS

31310 **Statistical fluctuations in the ionization yield and their relation to the electron degradation spectrum.** Inokuti, M.; Douthat, D.A.; Rau, A.R.P. (Argonne National Laboratory, Argonne, Illinois 60439). W-31-109-ENG-38. *Phys. Rev., A;* **22**: No. 2, 445-453(Aug 1980).

Various indices that characterize the statistical fluctuations in the ionization yield for electron incidence are discussed. The indices include the variance, the moments, the central moments, and the cumulants, all defined in terms of the probability $P(T_0,j)$ that an electron of kinetic energy T_0 causes, upon complete slowing down, exactly j ion pairs. Like the mean ionization yield, each of the indices is expressible as an integral over the current energy T of electrons. The integrand is a product of the Spencer-Fano degradation spectrum $y(T_0,T)$ for source energy T_0 with another factor, and displays contributions from different values of T to the quantity of interest. It has been shown for the first time that the cumulant of any order (including the variance as a special case) receives contributions from different T in nearly the same way as the mean ionization yield. Therefore, T_0 greatly exceeding the first ionization threshold, every cumulant is roughly proportional to T_0, just as the mean yield is. This leads to a generalization of the Fano factor. Thus the present findings reinforce the importance of the cumulant notion in statistical physics in general. Numerical work on molecular hydrogen as an

example substantiates the general conclusion and predicts the value 0.30 for the Fano factor for an electron of initial energy 10 keV.

31311 **Estimating the risk associated with computerized tomography doses.** Yalcintas, M.G. (Oak Ridge National Lab., TN); Leggett, R.W.; Dunning, D.E.; Nalcioglu, O. *Trans. Am. Nucl. Soc.;* **33**: 252-253(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

NEUTRON INTERACTIONS WITH MATTER

31312 (ANL/NDM—52) **Neutron total and scattering cross sections of ^{6}Li in the few MeV region.** Smith, A.; Guenther, P.; Whalen, J. (Argonne National Lab., IL (USA)). Feb 1980. Contract W-31-109-ENG-38. 44p. NTIS, PC A03/MF A01.

Neutron total cross sections of ^{6}Li are measured from ~ 0.5 to ~ 4.8 MeV at intervals of ~< 10 keV. Neutron differential elastic-scattering cross sections are measured from 1.5 to 4.0 MeV at ~> 10 scattering angles and at incident-neutron intervals of ~< 100 keV. Neutron differential inelastic-scattering cross sections are measured in the incident-energy range 3.5 to 4.0 MeV. The experimental results are extended to lower energies using measured neutron total cross sections recently reported elsewhere by the authors. The composite experimental data (total cross sections from 0.1 to 4.8 MeV and scattering cross sections from 0.22 to 4.0 MeV) are interpreted in terms of a simple two-level R-matrix model which describes the observed cross sections and implies the reaction cross section in unobserved channels; notably the (n;α)t reaction (Q = 4.783 MeV). The experimental and calculational results are compared with previously reported results as summarized in the ENDF/B-V evaluated nuclear data file.

31313 (DOE/ER/02280—40) **Computational complexity in multidimensional neutron transport theory calculations. Final report.** Bareiss, E.H. (Northwestern Univ., Evanston, IL (USA)). Dec 1979. Contract AS02-76ER02280. 7p. NTIS, PC A02/MF A01.

Research to establish a general method to assess the performance and reliability of computer codes for the numerical approximation of linear operators is reported. The neutron transport operator was chosen as model. The general approach to solving the error problem and the use of benchmarks are sketched. This report contains only a brief administrative summary; references are given to forty reports and publications that contain detailed information. (RWR)

31314 (LA-UR—80-1591) **Neutron cross section measurements at WNR.** Lisowski, P.W.; Archampaugh, G.F.; Moore, M.S.; Morgan, G.L.; Shamu, R.E. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 14p. (CONF-800551—13). NTIS, PC A02/MF A01.

From Symposium on neutron cross sections from 10 - 50 MeV; Upton, NY, USA (12 May 1980).

The Weapons Neutron Research Facility has been used to obtain moderate-resolution total neutron cross section data for H, C, ^{208}Pb, ^{232}Th, ^{238}U, and ^{242}Pu over the energy range 5 to 200 MeV. Neutrons were produced by bombarding a 2.5-cm diam by 15-cm long Ta target with an 800 MeV pulsed proton beam from LAMPF. A 10.2-cm diam by 15.2-cm thick NE110 proton recoil detector was used at a flight path of 32 meters, giving a time-of-flight resolution of 60 ps/m. The total cross section results are compared to ENDF/BV evaluations and to previous data where possible.

31315 (LA-UR—80-1592) **Status of high energy neutron cross sections.** Browne, J.C.; Lisowski, P.W. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 31p. (CONF-800551—12). NTIS, PC A03/MF A01.

From Symposium on neutron cross sections from 10 - 50 MeV; Upton, NY, USA (12 May 1980).

Review is presented of the current status of neutron-induced reactions of interest to the fusion community in the 10- to 50-MeV neutron energy range. Although there has been significant activity in this area since the 1977 BNL Symposium on Neutron Cross Sections from 10 to 40 MeV, this review concludes that there are many areas which require more experimentation to obtain the requested accuracy. Examples of various neutron data obtained since 1977 are presented and compared to determine the extent of agreement. An attempt is made to determine what the prospects are for satisfying the fusion data needs defined by the US DOE based upon progress to date.

31316 (UCID—18731) **Data testing results for the ENDF/B-V Evaluated Neutron Data File.** Howerton, R.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 4 Jul 1980. Contract W-7405-ENG-48. 36p. NTIS, PC A03/MF A01.

The ENDF/B-V Evaluated Neutron Data File has been tested for validity by comparing calculated and experimental values of k/sub eff/ for 66 critical assemblies and emission neutron spectra for 20 spheres that were pulsed with 14-MeV neutrons. 20 figures, 7 tables.

31317 (UCID—18749) **Flux weighted group cross sections based on the ACTLMFE data file.** Howerton, R.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jul 1980. Contract W-7405-ENG-48. 11p. NTIS, PC A02/MF A01.

A code, GPC, calculates flux-weighted group cross sections for up to 200 groups weighted by flux with up to 200 entries from the ACTLMFE data file, which is an ASCII form of the LLNL ACTL neutron activation cross section library.

SOLID STATE PHYSICS

REFER ALSO TO CITATION(S) 30374

31318 (SAND—80-0395C) **Effect of diffusion on the photoconductivity of thin films.** Hughes, R.C.; Sokel, R.J. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP000789. 9p. (CONF-800647—6). NTIS, PC A02/MF A01.

From International conference on the physics of MOS insulators; Raleigh, NC, USA (18 Jun 1980).

The equations governing time dependent and steady state photoconductivity are solved analytically for some approxiations and numerically in exact form. The diffusion terms are shown to be important especially in thin films. Some data of Farmer and Lee on photoconductivity in MOS structures is reinterpreted with losses due to diffusion to the contacts included.

31319 **Double-quantum cross-polarization NMR in solids.** Vega, S.; Shattuck, T.W.; Pines, A. (Department of Chemistry and Materials and Molecular Research Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev., A;* **22**: No. 2, 638-661(Aug 1980).

Double-quantum NMR is a useful way to obtain spectra of quadrupolar nuclei (^{2}D, ^{14}N, ...) in solids. This allows measurements of the chemical shifts for these nuclear spins. The theory of Hartmann-Hahn cross polarization between I=1/2 and such S=1 spins is discussed. Particular attention is drawn to the cross polarization of the double-quantum transition. The thermodynamics and the dynamics of the process are evoked in detail using a fictitious spin-1/2 formalism. The spin S=1 Hamiltonian can always be factored into two commuting parts (independent thermodynamic reservoirs), one of which behaves as a fictitious spin 1/2 which is cross polarized with the I=1/2 spins. Modified Hartmann-Hahn conditions emerge from the theory, and the dependence of cross-polarization times T/sub I/S on rf intensity and frequency for spin locking and adiabatic demagnetization in the rotating-frame experiments are calculated. Measurements on the ^{1}H-^{2}D double resonance in dilute solid benzene-d_1 are reported, verifying the predictions and indicating that cross polarization provides a sensitive means of detecting the ^{2}D double-quantum transition. Values are reported for the thermodynamic parameters and cross-polarization times as a consequence. Three possible versions of double-resonance detection of double-quantum spectra are possible: direct detection of the cross-polarized double-quantum decay, indirect detection of the frequency spectrum following Hartmann and Hahn, and indirect detection of the free-induction decay following Mansfield and Grannell.

31320 (TT—74-52000/04) **Ukrainian Physics Journal.** Translation of *Ukr. Fiz. Zh. (Russ. Ed.);* **17**: No. 4, vp.(Apr 1972). 205p. (AEC-tr—7411/4). NTIS, PC A10/MF A01.

A cover-to-cover translation into English of Volume 17, No. 4 (April 1972) of the Ukrainian Physics Journal (Ukrainskii Fizicheskii Zhurnal) is presented. Most of the articles in this issue are on solid state physics; other articles deal with plasmas, nuclear physics, lasers, atomic physics, and low temperature physics. Individual articles in scope for NSA were cited from the original-language publication. (RWR)

SUPERCONDUCTIVITY

ACOUSTIC, ELECTRIC, MAGNETIC, OPTICAL, AND THERMAL PHENOMENA

REFER ALSO TO CITATION(S) 30862

31321 (LBL—10976) **Operation of a forced two phase cooling system on a large superconducting magnet.** Green, M.A.; Burns, W.A.; Eberhard, P.H.; Gibson, G.H.; Pripstein, M.; Ross, R.R.; Smits, R.G.; Taylor, J.D.; Van Slyke, H. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1980. Contract W-7405-ENG-48. 11p. (CONF-800631—8). NTIS, PC A02/MF A01.

From 8. international cryogenic engineering conference; Genoa, Italy (3 Jun 1980).

This paper describes the operation of a forced two phase cooling system on a two meter diameter superconducting solenoid. The magnet is a thin high current density superconducting solenoid which is cooled by forced two phase helium in tubes around the coil. The magnet, which is 2.18 meters in diameter and 3.4 meters long, has a cold mass of 1700 kg. The two phase cooling system contains less than 300 liters of liquid helium, most of which is contained in a control dewar. This paper describes the operating characteristics of the LBL two phase forced cooling system during cooldown and warm up. The paper presents experimental data on operations of the magnet using either a helium pump or the refrigerator compressor to circulate two phase helium through the superconducting coil cooling tubes.

THEORETICAL PHYSICS

CLASSICAL AND QUANTUM MECHANICS

REFER ALSO TO CITATION(S) 31288

31322 (SAND—80-0314) **Aeroballistic analysis of ERB/TIGER II Aerodynamic Test Unit ATU-2 (SLA R715032).** Greene, R.W. (Sandia National Labs., Albuquerque, NM (USA)). Jul 1980. Contract AC04-76DP00789. 69p. NTIS, PC A04/MF A01.

The results of the first drop test of the 13.3-in-diameter ERB/TIGER II are documented. The test unit, designated Aerodynamic Test Unit-2 (ATU-2), was dropped on August 25, 1977, at the Sandia National Laboratories Tonopah Test Range from an Air Force F-4 Aircraft. Nominal release conditions were an altitude of 20,000 ft mean sea level and Mach 0.8. The purpose of the test was to obtain free-flight vehicle characteristics including the effect of the free-floating rollerons, to evaluate release and separation characteristics of the 13.3-in-diameter vehicle, and to evaluate the performance of the recovery system. Modifications to the mathematical model for the vehicle that yield better agreement between simulation and flight test results are presented. The system is also described. 42 figures, 2 tables.

31323 (SAND—80-8225) **Users manual for GNATS2 (a finite element computer program for the general nonlinear analysis of two-dimensional structures).** Callabresi, M.L.; Chiesa, M.L. (Sandia National Labs., Albuquerque, NM (USA)). Jul 1980. Contract AC04-76DP00789. 107p. NTIS, PC A06/MF A01.

GNATS is a system of three user-oriented finite element computer programs designed for the nonlinear analysis of axisymmetric and two-dimensional static structures. A preprocessor program, MESH2, provides the two-dimensional finite element mesh. The main program, GNATS, solves the nonlinear structural problem including the effects of large displacements, large strains, and elastic-plastic material behavior. A Lagrangian coordinate system is used in GNATS for describing the euilibrium configuration of the body. A postprocessor program, GPRINT, prints the selected values of displacements, stresses, and strains. The input data required for using MESH2, GNATS, and GPRINT for a nonlinear structural analysis is described. Dynamic dimensions are used for all arrays in these programs. The maximum problem size, therefore, is limited only by the computer being used. 61 figures, 4 tables.

31324 Coherent states for general potentials. IV. Three-dimensional systems. Nieto, M.M. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., D;* **22**: No. 2, 391-402(15 Jul 1980).

The minimum-uncertainty coherent-states formalism is extended to higher-dimensional systems. Specifically, for spherically symmetric three-dimensional potentials the formalism looks for coherent states which are products of an angular wave function times a radial wave function. After reviewing the many studies on angular coherent states, I concentrate on the physically distinguishing radial coherent states. The radial formalism is explained in detail and contrasted with the effective one-dimensional formalism. The natural classical variables in the radial formalism are those which vary sinusoidally as $g(E,L)\theta(t)$, where $\theta(t)$ is the real azimuthal angular variable and $g(E,L)$ is the number of oscillations between apsidal distances per classical orbit. When changed to natural quantum operators, these operators can be given as the Hermitian sums and differences of the "I" raising and lowering operators. The formalism is applied to the three-dimensional harmonic-oscillator and Coulomb problems.

31325 Coherent states for general potentials. V. Time evolution. Gutschick, V.P.; Nieto, M.M. (Theoretical Division and Life Sciences Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., D;* **22**: No. 2, 403-418(15 Jul 1980).

We show the time evolution of minimum-uncertainty coherent-state (MUCS) wave packets in the solvable potentials we have considered. (Numerical techniques are discussed in the appendices.) The time evolution is compared to the motion that a classical particle would have in the same potential. We make a number of observations on the conditions which can cause the states to lose their coherence more (or less) rapidly with time, and compare the MUCS results with those which can be obtained from other types of coherent states. The most physically interesting comparison is with the "continuous representation" coherent states.

31326 Periodic spontaneous collapse and revival in a simple quantum model. Eberly, J.H.; Narozhny, N.B.; Sanchez-Mondragon, J.J. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627). *Phys. Rev. Lett.;* **44**: No. 20, 1323-1326(19 May 1980).

This Letter reports on the existence of periodic spontaneous collapse and revival of coherence in the dynamics of a simple quantum model. Also given are the first accurate expressions for the intermediate-time and long-time dynamical behavior of the model.

MATHEMATICAL PHYSICS

31327 (DOE/ER—3077-167) **Random choice finite-difference scheme for hyperbolic conservation laws.** Harten, A.; Lax, P.D. (New York Univ., NY (USA). Courant Mathematics and Computing Lab.). May 1980. Contract AC02-76ER03077. 61p. NTIS, PC A04/MF A01.

The random choice method of Glimm is modified by replacing the exact solution of the Riemann problem with an appropriate finite difference approximation. This modification resolves discontinuities as well as Glimm's scheme, but is computationally more efficient and is easier to extend to more general situations. 2 tables.

31328 (LA-UR—80-1721) **Practical applications of adaptive mesh refinement (rezoning).** Guerra, F.M.; Humphrey, D.L.; Hoffman, R.E. (Los Alamos Scientific Lab., NM (USA); California Univ., Livermore (USA). Lawrence Livermore Lab.; Earl and Wright Consulting Engineers, San Francisco, CA (USA)). 1980. Contract W-7405-ENG-36. 42p. (CONF-7905164—1). NTIS, PC A03/MF A01.

From Engineering application of the finite element method conference; Oslo, Norway (May 1979).

A collection of finite element problems that have been examined with a posteriori convergence measures is presented. Results show that these local convergence measures can be used to indicate the quality of a finite element solution and to suggest boundaries for mesh rezones. 18 figures, 1 table.

FUSION ENERGY

PLASMA RESEARCH

REFER ALSO TO CITATION(S) 31320

PLASMA CONFINEMENT AND HEATING

REFER ALSO TO CITATION(S) 31342

31329 Device and method for electron beam heating of a high density plasma. Thode, L.E. US Patent Application 071,603. [nd]. 40p.

A device and method for relativistic electron beam heating of a high density plasma in a small localized region are described. A relativistic electron beam generator produces a high voltage electron beam which propagates along a vacuum drift tube and is modulated to initiate electron bunching within the beam. The beam is then directed through a low density gas chamber which provides isolation between the vacuum modulator and the relativistic electron beam target. The relativistic beam is then applied to a high density target plasma which typically comprises DT, DD, hydrogen boron or similar thermonuclear gas at a density of 10^{17} to 10^{20}.

31330 (PPPL—1672) **Temporal evolution of lower hybrid waves in the presence of ponderomotive density fluctuations.** Karney, C.F.F. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Jun 1980. Contract AM02-76CH03073. 26p. NTIS, PC A03/MF A01.

The propagation of lower hybrid waves in the presence of ponderomotive density density fluctuations is considered. The problem is treated in two dimensions and, in order to be able to correctly impose the boundary conditions, the waves are allowed to evolve in time. The fields are described by i upsilon/sub tau/ - $\int$ upsilon/sub xi/d/sub zeta/ + upsilon/sub zeta zeta/ + upsilon/^{1} upsilon = 0 where upsilon is proportional to the electric field, tau to time, and zeta and xi measure distances across and along the lower hybrid ray. The behavior of the waves is investigated numerically. If the ampli-

tude of the waves is large enough, the spectrum of the waves broadens and their parallel wavelength becomes shorter. The assumptions made in the formulation preclude the application of these results to the lower hybrid heating experiment on Alcator-A. Nevertheless, there are indications that the physics embodied in this problem are responsible for some of the results of that experiment.

31331 (PPPL—1699) **Effect of resonance broadening on the evolution of the edge of a turbulent spectrum.** Kritz, A.H.; Fisch, N.J.; Karney, C.F.F. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Jun 1980. Contract AM02-76CH03073. 22p. NTIS, PC A02/MF A01.

The extent to which nonlinear wave-particle resonance broadening results in a narrowing of an incident lower-hybrid wave spectrum is investigated. This narrowing is of concern because it could make control of lower-hybrid heating difficult. We numerically show, however, that relatively uniform spatial power deposition occurs if resonance broadening effects are treated consistently on both the wave spectrum and the particle distribution. A more naive approach, including only the effects on the evolution of the wave spectrum, would incorrectly predict an unfavorable power deposition profile.

31332 **End loss from a high-beta plasma column.** Brunel, F.; Tajima, T.; Leboeuf, J.N.; Dawson, J.M. (Physics Department, University of California, Los Angeles, California 90024). *Phys. Rev. Lett.;* **44**: No. 23, 1494-1497(9 Jun 1980).

The previous theoretically predicted diverging confinement time of a high-β linear sharp plasma column as $\beta \rightarrow 1$ is removed by including the magnetic tension effect near the column throats. This result explains our own simulation as well as those of Brackbill, Menzel, and Barnes, and is in good agreement with experimental values. The confinement time tau of a plasma with thickness a and length L at $\beta=1$ is found to be tau3/43/2π)/sup 1/2/(L/2c/sub s/)(L/a)/sup 1/2/.

31333 **Enhanced plasma confinement by MHD oscillation.** Cary, J.R.; Hammer, J.H. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). *Comments Plasma Phys. Controlled Fusion;* **5**: No. 4, 159-165(Dec 1979).

The use of MHD oscillations to enhance plasma confinement in mirror machines is proposed. A small MHD oscillation (deltaB²/8πnTsub(i) approximately 0.1) produces a ponderomotive-potential well in the center of the machine, trapping ions with small parallel energy, and thereby stabilizing the DCLC mode. A large oscillation (deltaB²/8πnTsub(i) > = 1.0) enhances confinement beyond classical.

PLASMA DIAGNOSTICS

31334 (ORNL/TM—7300) **Approach to rapid plasma shape diagnostics in tokamaks.** Lee, D.K.; Peng, Y.K.M. (Oak Ridge National Lab., TN (USA)). Jul 1980. Contract W-7405-ENG-26. 36p. NTIS, PC A03/MF A01.

A deterministic approach to estimating the plasma boundary shape and location, based only on the signals of small B vector pickup loops in the vicinity of the plasma, is studied. The pickup loops provide information on ∂ B/sub R//∂ t and B/sub Z//∂ t, which can be processed to provide data on B/sub R/, B/sub Z/, psi, and psi/∂ n (normal derivative), thus leading to a Cauchy boundary condition for solving Δ*psi = 0 between the loop locations and the plasma boundary flux surface. Numerical equilibria calculated for the Impurity Study Experiment (ISX-B) with different shapes are used to simulate pickup loop signals. Random errors are added to the signals to test the efficacy of two different approaches: global fitting and local fitting. Reasonably accurate results are obtained by the method of global fitting of the boundary values, which is based on the expansion of psi in terms of eigenfunctions of Δ*psi = 0 in a toroidal ring coordinate system. This approach is shown to permit a random error of nearly 100% in poloidal B vector field values at the loops and still reproduce the plasma shape and location within a few percent. This method appears to have the potential of rapidly displaying the plasma shape and location.

31335 (PPPL—1673) **Performance study of the TFTR diagnostic neutral beam for active charge exchange measurements.** Medley, S.S.; Goldston, R.J.; Towner, H.H. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Jun 1980. Contract AM02-76CH03073. 70p. NTIS, PC A04/MF A01.

A neutral beam source will be incorporated in the Tokamak Fusion Test Reactor (TFTR) charge exchange diagnostic to provide a time modulated, spatially localized enhancement of the charge exchange efflux. Two autonomous Charge Exchange Neutral Analyzer (CENA) systems are being designed for the TFTR. One system measures the plasma ion temperature along twelve vertical line-of-sight chords spaced approximately equidistantly across the torus minor diameter. The other system is dedicated primarily to measurement of ion phenomena associated with neutral beam injection heating and has a fan-like field of view along eight sight-lines in the equitorial plane. The neutral beam is steerable in order to access the viewing field of both CENA systems, though in general not simultaneously. The performance of the diagnostic neutral beam is evaluated to determine the optimal beam specifications for active charge exchange measurements. Using the optimal beam design parameters, the efficacy of the neutral doping is examined for both CENA systems over the envisioned range of the TFTR plasma density and temperature.

31336 **X-ray diagnostics of plasmas in the PLT and PDX tokamaks.** Sauthoff, N.R.; Bitter, M.; Hill, K.W.; Silver, E.; Stodiek, W.; von Goeler, S.; Eames, D.R. (Princeton Univ., NJ). *Trans. Am. Nucl. Soc.;* **33**: 242-244(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

PLASMA KINETICS - EXPERIMENTAL

31337 (DOE/ET/51010—8) **Experimental study of unipolar arcs in a low pressure mercury discharge.** Johnson, C.T. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Fusion Power Systems Dept.). 31 Dec 1979. Contract AC02-77ET51010. 54p. (WFPS-TME—79-033). NTIS, PC A04/MF A01.

An experimental study of unipolar arcs was conducted in a low pressure mercury discharge inductively heated with RF. The results were found to be consistent with the concept of a sheath mechanism for driving the unipolar arcs. Floating double-probe measurements of the unipolar arc plasma parameters yielded electron temperatures of ~ 2 eV and electron number densities of ~ 1 x 10^{11} cm^{-3} assuming quasi-neutral plasma conditions. The variation of the unipolar arc current with: (1) the RF power input; and (2) the metal surface area exposed to the plasma verified the predicted dependence of the arc current on the plasma parameters and the metal surface area. Finally, alternative mechanisms for sustaining the observed arcs by high frequency rectification were ruled out on the basis of the recorded current waveforms of the unipolar arcs.

31338 (PPPL—1677) **Effect of plasma surface interactions on PLT plasma parameters.** Meservey, E.B.; Arunasalam, V.; Barnes, C. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Jul 1980. Contract AM02-76CH03073. 17p. NTIS, PC A02/MF A01.

This paper gives a brief description of the geometry and parameters of the PLT tokamak, reviews some of the last four years' results that are particularly relevant to plasma-boundary interactions, and then concentrates on two specific problems.

31339 **Polarization of electron cyclotron emission from Alcator tokamak.** Hutchinson, I.H. (Massachusetts Inst. of Tech., Cambridge (USA). Francis Bitter National Magnet Lab.). *Plasma Phys.;* **21**: No. 12, 1043-1052(Dec 1979).

A detailed study of the polarization of the electron cyclotron radiation in Alcator has been undertaken. A polarizing Michelson interferometer and a Fabry-Perot and rotating polarizer combination are used to obtain frequency resolved measurements of the polarization parameters. The observed direction of polarization is consistent with the expected limiting polarization of the modes propagating out of the plasma, including the effects of poloidal field. In certain circumstances the observed polarization varies with frequency, equivalent to a slight shift of the extraordinary mode to lower frequencies. This is attributed to the toroidal magnetic field ripple.

31340 **measurement of the neutron spectra from beam-heated PLT plasmas.** Strachan, J.D.; Colestock, P.; Eubank, H. (Princeton Univ., NJ (USA). Plasma Physics Lab.). *Nature (London);* **279**: No. 5714, 626-628(14 Jun 1979).

Measurements of the neutron spectra from the PLT tokamak plasma reported here provide information on the centre-of-mass velocity of the reacting deuteron pairs. It was found that no measurable velocity was induced by hydrogen neutral beam injection and that the shape of the experimental neutron emission line was consistent with a thermonuclear neutron emission at the ion temperature predicted by the magnitude of the neutron emission. Both these observations are consistent with a thermonuclear origin of the PLT neutrons during hydrogen neutral beam heating of a deuterium plasma.

31341 **Use of Auger electron spectroscopy in tokamak gettering rsearch.** Malinowski, M.E. (Sandia Labs., Albuquerque, NM). *Trans. Am. Nucl. Soc.;* **33**: 244-245(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

PLASMA KINETICS - THEORETICAL

REFER ALSO TO CITATION(S) 31354, 31355, 31356

31342 (DOE/ET/53036—18) **Tokamak currents driven by weak electrostatic waves.** Hitchcock, D.A.; Mahajan, S.M. (Texas Univ.,

Austin (USA). Dept. of Physics). Jul 1980. Contract AC05-76ET53036. 10p. NTIS, PC A02/MF A01.

The generation of steady state currents by weak electrostatic waves is examined via a perturbative treatment. An exact solution of the first order equation is found. The amount of power required to sustain currents is evaluated.

31343 (DOE/ET/53051—4) **Observations of neoclassical and anomalous resistivity in toroidal discharges.** Etzweiler, J.F.; Brouchous, D.A. (Wisconsin Univ., Madison (USA)). Mar 1980. Contract AS02-76ET53051. 43p. NTIS, PC A03/MF A01.

Plasma resistivity measurements parallel to the magnetic field have been made on the ?Wisconsin supported octupole and the Wisconsin levitated octupole. Plasmas ranged in density from 10^{8} cm^{-3} to 10^{12} cm^{-3} and varied from highly collisionless to highly collisional. The measured resistivity was found to agree with neoclassical resistivity theory in the collisional and transition regimes. Highly collisionless plasmas were found to have anomalously high resistivity which obeyed the T/sub e//sup 1/2//n/sub e/ scaling of the transition regime.

31344 (IAEA-CN—38/BB-3-2) **Physics of hot electron rings in EBR: theory and experiment.** Uckan, N.A.; Hedrick, C.L.; Haste, G.R. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 17p. (CONF-800707—17). NTIS, PC A02/MF A01.

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

Confinement and scaling characteristics of the high-beta, hot electron rings (annuli) in ELMO Bumpy Torus (EBT) are studied. The rings are produced by electron cyclotron heating and form at the location of the second harmonic resonance. This study examines drift orbits, microwave heating, equilibrium and stability requirements of the hot electrons, and their interaction with the toroidal core plasma. Reasonable agreement is found to exist among theoretical predictions, observed ring behavior, measured ring parameters, and power losses. Also analyzed is dimensionless parameter scaling of the rings, which implies favorable reactor performance.

31345 (PPPL—1639) **Computer simulations of anomalous transport.** Lee, W.W.; Okuda, H. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Jul 1980. Contract AM02-76CH03073. 12p. (CONF-800409—6). NTIS, PC A02/MF A01.

From International conference on plasma physics; Nagoya, Japan (7 Apr 1980).

Numerical plasma simulations have been carried out to study: (1) the turbulent spectrum and anomalous plasma transport associated with a steady state electrostatic drift turbulence; and (2) the anomalous energy transport of electrons due to shear-Alfven waves in a finite-β plasma. For the simulation of the steady state drift turbulence, it is observed that, in the absence of magnetic shear, the turbulence is quenched to a low level when the rotational transform is a rational number, while the turbulent level remains high for an irrational rotational transform.

31346 (PPPL—1678) **Solving the Chirikov Taylor model by the method of paths in Fourier space.** Rechester, A.B.; Rosenbluth, M.N.; White, R.B. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Jul 1980. Contract AM02-76CH03073. 25p. NTIS, PC A02/MF A01.

A compact path-diagram method has been introduced for the calculation of velocity moments of a probability function. This method is complementory to the approach developed earlier. It is applied to the Chirikov-Taylor model. A number of new results have been derived and verified by numerical computations.

31347 (PPPL—1682) **Incorrectness of the usual gyrokinetic treatment in cylindrically symmetric systems.** Linsker, R. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Jul 1980. Contract AM02-76CH03073. 24p. NTIS, PC A02/MF A01.

It is shown that the usual gyrokinetic theory does not consistently retain all terms of leading order in the expansion parameter epsilon = gyroradius/equilibrium scale length. This is illustrated for cylindrically symmetric systems by comparing the perturbed distribution function calculated by the gyrokinetic method with that obtained by explicitly integrating the Vlasov equation over the unperturbed orbit. The integral equation used in some recent treatments of drift waves in sheared-slab geometry is shown to be incorrect. The correct calculation of the ion density perturbation for a collisionless $\beta = 0$ plasma with cylindrical symmetry is presented.

31348 (UCRL—84261) **Model for H^- and D^- production by hydrogen backscattering.** Hiskes, J.R.; Schneider, P.J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.; California Univ., Livermore (USA). Lawrence Livermore Lab.). 27 May 1980. Contract W-7405-ENG-48. 15p. NTIS, PC A02/MF A01.

The Marlowe Monte-Carlo backscattering code has been used to calculate particle reflection coefficients and energy distributions for H, D incident upon Li, K, Ni, Cu, Mo, Ag, Cs, Hf, W, Pt, and U surfaces. The backscattered energy and angular distributions are combined with a model for formation and survival probabilities for H^-, D^- leaving the surface. A least-squares fit of experimental measurements of H^- yields from the composite surface, Cs/Cu, has been used to obtain two semi-empirical constants, α, β which enter into the formation and survival probabilities. These probabilities are used to calculate the production probability which in turn provides an upper limit to the negative ion yield. The choice of electrode material is discussed as a function of atomic number.

31349 (ORNL/tr—4667) **Problems in the evolution of equilibria of toroidal configurations.** Zakharov, L.E.; Shafranov, V.D. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). Jul 1980. Translation of IAE—3075, 1978. 80p. NTIS, PC A05/MF A01.

Phenomena are described that have complicated the problem of the evolution of equilibrium configurations (i.e., the change in time of the conditions of MHD equilibrium, the form of the magnetic surfaces, the current distribution, etc.) in the presence of relaxation effects related to finite plasma conductivity. As we have noted in an earlier paper, the evolution of equilibria is distinct from the general problem of modeling processes in the plasma because of the independence of magnetic field diffusion from diffusion of the plasma itself. This allows one to formulate the evolution problem cleanly, without accounting for the complicated processes of the transport of particles and heat. In the paper we give basic equations and boundary conditions for either the current or the poloidal field in various formulations that occur when the plasma configuration is changed by a pressure rise and the equilibrium is maintained either by a shell or by external fields. We consider fundamental questions qualitatively, using characteristic examples to illustrate special problems in the evolution of equilibria. Specifically, we consider the process of the possible decay of a high pressure configuration obtained under flux-conserving conditions.

31350 **Nernst-Wienecke equilibrium in linear magnetized plasmas.** Ahlborn, B. (Washington Univ., Seattle (USA). Dept. of Nuclear Engineering). *Can. J. Phys.;* **57**: No. 8, 1090-1093(Aug 1979).

A cylindrical hydrogen plasma embedded in a strong axial magnetic field, in which a temperature maximum is maintained by axial heating and radial heat transfer, has a pressure maximum and a density minimum on axis. The pressure in dyn/cm^2 and density in cm^{-3} can be approximated as p approximately equal to 1.8 x 10^{-5} BT sup(3/4) and n sub(e) approximately equal to 6.4 x 10^{12} BT sup(1/4) (B in gauss and T in kelvin).

31351 **Plasma transport in stochastic magnetic fields, 2. Principles and problems of test electron transport.** Krommes, J.A. (Princeton Univ., NJ (USA). Plasma Physics Lab.). *Prog. Theor. Phys. (Kyoto), Suppl.;* No. 64, 137-149(Apr 1979).

From International symposium on nonlinear nonequilibrium statistical mechanics; Kyoto, Japan (10 - 14 Jul 1978).

Plasma confinement in toroidal devices may be significantly degraded because of flux surface destruction and consequent stochastic wandering of magnetic lines. In this study a model stochastic differential equation is considered which describes guiding center electron motion in a statistically specified spectrum of turbulent magnetic fluctuations. The fluctuation intensity is assumed to satisfy the Chirikov criterion (Resonance overlap) for onset of stochasticity. In this limit typical lines diffuse and are adequately described by a quasilinear diffusion coefficient D sub(m). However, quasilinear theory does not describe an important mechanism for loss of particle correlations: Particles collisionally diffuse from one line to an adjacent one which diverges rapidly from the first, carrying the particles away. The scale length L sub(k) for line divergence is related to the inverse of the Kolmogorov-Sinai entropy. An attempt is made to determine L sub(k) from a simplified Eulerian vertex renormalization. The exponentiation length which emerges is L sub(k) -- L sub(s) (k sub(theta)sup(2)D sub(m)'' L sub(s))sup(-1/3), where L sub(s) is the shear length, k sub(theta) is a typical azimuthal wavenumber, and D sub(m)'' is of order D sub(m). In a particular limit of weak shear, the particle diffusion coefficient can then be estimated as D -- $\Delta\gamma^2$/tau sub(c), where $\Delta\gamma^2$ -- D sub(m)z(tau sub(c)), z(tau) is the distance traveled along the lines in time tau, and for static fluctuations tau sub(c) -- tau(L sub(delta)), where L sub(delta) is L sub(k) multiplied by a logarithmic factor involving the perpendicular collisional diffusion coefficient. The problems of more refined quantitative computations from the renormalized kinetic equation are severe, and further study is necessary.

PLASMA INSTABILITIES

31352 **Effect of current shear on the tearing instability.** Barker, R.J.; Buneman, O. (Stanford Univ., CA (USA). Inst. for Plasma Research). *J. Plasma Phys.;* **22**: No. , 453-476(Dec 1979).

A fully relativistic stream superposition model is employed to conduct a linear numerical simulation of a self-consistently confined sheet of collisionless, neutral plasma. The multi-stream model employs a novel variable termed the 'canonical momentum potential' (or 'action function') to follow the ion and electron dynamics. For the classic, unsheared sheet pinch, growth rates obtained for the

tearing instability are in reasonable agreement with the previous estimates using an approximate Vlasov approach. Current shear is then introduced into the sheet and growth rates are again measured. Stabilization of the shorter wavelength modes is observed.

31353 (PPPL—1674) **Causes of major tokamak disruptions.** White, R.B.; Monticello, D.A. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Jul 1980. Contract AM02-76CH03073. 18p. NTIS, PC A02/MF A01.

The nonlinear saturation theory of the tearing mode is used to examine the necessary conditions for the occurrence of a major tokamak disruption. The results are compared with full three-dimensional numerical simulations, and with experimental data.

31354 (PPPL—1675) **Theory of drift, trapped-particle, and Alfven instabilities and anomalous plasma transport.** Chen, L.; Chance, M.S.; Cheng, C.Z. (Princeton Univ., NJ (USA). Plasma Physics Lab.; Maryland Univ., College Park (USA); California Univ., Livermore (USA). Lawrence Livermore Lab.; Oak Ridge National Lab., TN (USA)). Jul 1980. Contract AM02-76CH03073. 17p. NTIS, PC A02/MF A01.

Separate abstracts were prepared for each of the two included sections. (MOW)

31355 (PPPL—1675, pp 1-7) **Drift, trapped-particle, and Alfven instabilities and anomalous plasma transport.** Chen, L.; Chance, M.S.; Cheng, C.Z. (Princeton Univ., NJ). Jul 1980.

In Theory of drift, trapped-particle, and Alfven instabilities and anomalous plasma transport.

Results are presented of theoretical investigations on the linear and nonlinear aspects of microscopic low-frequency drift, trapped-particle, and shear-Alfven instabilities in systems with finite magnetic shear. The investigations employ analytical and numerical methods, and also particle simulations. In particular, the following subjects are considered: (1) stability of drift-wave eigenmodes in a sheared slab geometry including finite ion-temperature gradients; (2) instabilities in the neutral-beam-heated PLT; (3) application of the ballooning-mode formalism to drift, trapped-electron and shear-Alfven instabilities in toroidal geometry; and (4) nonlinear interactions of drift and drift-Alfven waves and associated anomalous transport.

31356 (PPPL—1675, pp 8-14) **Destabilization of low mode number Alfven modes in tokamaks by energetic beam or alpha particles.** Tsang, K.T.; Sigmar, D.J.; Whitson, J.C. (Oak Ridge National Lab., TN). Jul 1980.

In Theory of drift, trapped-particle, and Alfven instabilities and anomalous plasma transport.

It is shown that finite ion-Larmor-radius effects can remove the shear-Alfven continuous spectrum extensively discussed in ideal magnetohydrodynamic (MHD) theories. In the absence of free energy or dissipation, the resultant eigenmodes are discrete and neutrally stable. Toroidal drifts of alpha (or energetic) particles are found to destabilize these modes. Stability studies of the parametric variations of the energy and density scale lengths of the energetic particles show that, even in the presence of electron Landau damping, modes with low radial mode numbers remain unstable in most cases. Since alpha particles are concentrated in the center of the plasma, this drift-type instability may imply anomalous He-ash removal.

31357 **Nonlinear saturation of the Buneman instability.** Ishihara, O.; Hirose, A.; Langdon, A.B. (Department of Physics, University of Saskatchewan, Saskatoon S7N 0W0, Canada). W-7405-ENG-48. *Phys. Rev. Lett.;* **44**: No. 21, 1404-1407(26 May 1980).

An analytical model is developed for the nonlinear evolution of electron-ion two-stream instability. The instability saturates when the electric field energy reaches ~ 2(m/M)/sup 1/3/ W_0 (W_0=initial electron drift energy density), and is then followed by an algebraic growth. Complete stabilization is caused by electron trapping in deformed potential wells due to the rise of higher harmonics. The analytical model results are in close agreement with nonlinear kinetic computer simulations.

31358 **Analytical representation and physics of ballooning modes.** Coppi, B. (Massachusetts Inst. of Tech., Cambridge); Filreis, J.; Pegoraro, F. . *Ann. Phys. (N.Y.);* **121**: No. 1-2, 1-31(1 Sep 1979).

The topological and physical characteristics of the modes that can be excited in magnetically confined plasmas, with two-dimensional equilibrium configurations, are recognized. In particular, a direct three-dimensional representation of the modes that are typical of axisymmetric toroidal configurations is given on the basis of their general symmetry properties and, from this, the critical pressure gradient for their onset in the ideal MHD approximation can be evaluated. These modes are driven by the locally unfavorable magnetic curvature over an interval of a given field line where the mode amplitude is largest, and since the plasma is constrained to move with the magnetic field, they can be excited only when the plasma pressure becomes a finite fraction of the magnetic pressure. Other modes, that are topologically similar but exist for lower values of the plasma pressure relative to the magnetic pressur- --e found when dissipative or velocity space effects are taken into account. From the topology point of view, it is pointed out that the so-called disconnected-mode description of ballooning modes which have strongly varying amplitude over a given field line, is adequate in most cases of interest. In fact, disconnected modes act on successive periodically spaced intervals of a given field line as if these were independent of each other. The disconnecting property is related to the effects of magnetic shear.

31359 (DOE/ET/53045—1) **Most probable ideal magnetohydrodynamic equilibria. I. Tokamak regime and quasi-force-free states.** Ambrosiano, J.; Vahala, G. (College of William and Mary, Williamsburg, VA (USA). Dept. of Physics). [nd]. Contract AS05-76ET53045. 31p. NTIS, PC A03/MF A01.

Given the information on only a few global parameters (e.g., energy E, magnetic helicity H, flux phi, current I, ... - constraints that can be either experimentally imposed or constants of the motion...) the statistical theory of Montgomery, Turner and Vahala, which determines the most probable ideal magneto-hydrodynamic equilibrium compatible with the given information, is investigated in the tokamak regime. It is shown that in this regime of phi >> I one obtains typical experimentally relevant profiles e.g. B/sub θ/ << B/sub z/, slightly diamagnetic toroidal fields with torodial currents peaked on axis. A sequence of most probable equilibria, with decreasing ratio of E/H at fixed phi and I, is investigated showing less diamagnetic states with rapidly decreasing plasma beta. Linearized analytic force-free states can also be constructed for certain regimes of the global parameters together with their nonlinear quasi-force-free counterparts.

31360 (DOE/ET/53045—2) **Most probable ideal magnetohydrodynamic equilibria. II. Reversed field pinch regime.** Ambrosiano, J.; Vahala, G. (College of William and Mary, Williamsburg, VA (USA). Dept. of Physics). [nd]. Contract AS05-76ET53045. 29p. NTIS, PC A03/MF A01.

The statistical theory presented in Part I is extended to allow the toroidal field B/sub z/(r) to be an arbitrary function of r so as to allow the possibility of reversed field most probable states. It is found that in the reversed field pinch regime, phi << I, that decreasing E/H at fixed phi and I leads to a sequence of most probable equilibria with increasing field reversal and hollow pressure profiles on axis - in marked contrast to the corresponding behavior in the tokamak regime (phi >> I) in which B/sub z/ becomes a uniform field as E/H decreases. It appears that in both regimes the most probable equilibria are becoming more stable as E/H decreases.

PLASMA WAVE PHENOMENA

REFER ALSO TO CITATION(S) 31263, 31331

31361 **cw far-infrared laser scattering from a laboratory plasma.** Park, H.; Peebles, W.A.; Mase, A.; Luhmann, N.C. Jr.; Semet, A. (University of California, Los Angeles, California 90024). DE-AM03-76-SF00010. *Appl. Phys. Lett.;* **37**: No. 3, 279-282(1 Aug 1980).

The first far-infrared laser (λ_0=1.22 and 0.447 mm) scattering experiment in a laboratory plasma is described. cw laser radiation is scattered at large angles (0 °—20 °) from ion acoustic waves launched in a low-density (n/sub e/ $\simeq 10^{10}$ cm^{-3}) plasma thereby allowing detailed comparison with Langmuir probe data. Measurement of the wave-number resolution and studies of both linear and nonlinear ion waves are presented. Future application areas are briefly described.

31362 **Interaction of magnetic plasma fluctuations with fusion produced α-particles.** Coppi, B.; Pegoraro, F. (Massachusetts Inst. of Tech., Cambridge (USA)). *Comments Plasma Phys. Controlled Fusion;* **5**: No. 4, 131-140(Dec 1979).

A study is made of the effects of fusion-produced α particles on magnetic plasma fluctuations. It is found generally that α particles cannot provide an effective amplification of wave packets.

FUSION POWER PLANT TECHNOLOGY

31363 (DOE/ER—0062) **Compact Toroid Theory Planning Workshop. A panel report to the Director, Division of Applied Plasma Physics, Office of Fusion Energy.** (Department of Energy, Washington, DC (USA). Office of Fusion Energy). Jul 1980. 21p. NTIS, PC A02/MF A01.

The purpose of the Workshop was to identify the most important physics issues that need to be addressed in the near term in order to assure the optimal design and timely interpretation of Compact Toroid (CT) experiments. The Panel was also asked to assess the levels of effort required to obtain priority information on appropriate time scales compatible with DOE plans to design a CT proof-of-principle experiment. The fiscal year cost anticipated for

the effort recommended by the Workshop Panel (excluding costs for computing) is estimated to be approximately $5.7M. CT theory is currently funded at a level of approximately $2.0M per year.

31364 (DOE/ET/53051—123) **Plasma physics research. Technical progress report, 1 February 1979-30 September 1980.** (Wisconsin Univ., Madison (USA). Dept. of Physics). 1980. Contract AS02-76ET53051. 45p. NTIS, PC A03/MF A01.

Progress during the 20-month period, Feburary 1, 1979 to September 30, 1980 on the University of Wisconsin Plasma Physics contract is described. Most of the work centers around two large experimental devices, the Levitated Octupole and Tokapole II. A major upgrade of the Octupole was begun to include 1.8 MW of neutral beam heating and 2 MW of ICRH. Meanwhile, gun optimization and low field operation has resulted in the attainment of 35% beta, a factor of 9 above the single fluid ballooning limit. The Tokapole has operated reliably for the past two years and has been used to study axisymmetric instability of dee, inverse dee, and square shaped plasmas. Low q ($\sim$ 0.6) discharges with flat current profiles are obtained. ICRF heating studies were brought to a conclusion. The device is presently being used to study Alfven wave heating, ECRH startup, poloidal ohmic heating, and plasma ohmic heating, and plasma surface interactions. Smaller efforts on divertor simulation and plasma potential studies in a single ring device and plasma theory are also described.

31365 (GA-A—15869) **Doublet III: status and future plans.** Rawls, J.M. (General Atomic Co., San Diego, CA (USA)). Apr 1980. Contract AT03-76ET51011. 19p. (CONF-8004100—1). NTIS, PC A02/MF A01.

From 4. International Atomic Energy Agency technical committee meeting on large tokamak experiments; Tokyo, Japan (14 Apr 1980).

A synopsis is presented of the experimental results from the ohmic heating phase of Doublet III, with emphasis on the production of good target plasmas for the upcoming neutral beam injection phase. The program plan for the device over the life of the US-Japan cooperative program is discussed, as is the status of the preliminary investigation into replacing the present vacuum vessel by one better suited for ETF simulation.

31366 (MSNW—80-1144-3) **CT-TRX1, a triggered-reconnection compact toroid experiment.** Hoffman, A.L. (Mathematical Sciences Northwest, Inc., Bellevue, WA (USA)). May 1980. Contract AC06-76ET53027. 44p. NTIS, PC A03/MF A01.

A new compact toroid experiment, CT-TRX1, based on the field reversed theta pinch is under construction. The unique feature of this experiment is the incorporation of several quasi-steady and pulsed magnets to carefully control the reconnection process. The motivation for this emphasis is to duplicate and extend the results reported by Kurtmullaev, et al., where delayed reconnection produced efficient axial shock heating and resulted in large diameter compact toroids which exhibited complete MHD stability for the 100 μsec decay time of their pulsed magnets. CT-TRX1 incorporates moderate E/sub θ/ radial shock heating, along with the triggered reconnection capability, to investigate the full range of conditions between the USSR experiments and the radial shock heated experiments at LASL, where m = 2 rotational instabilities occur. An additional feature of CT-TRX1 is the incorporation of a compound magnet which will provide long magnetic field decay times. The requirements for both high field quasi-steady outer magnets, and several high voltage, individually triggered pulsed inner magnets, present unique engineering design problems which are discussed.

31367 (PNL—3116) **Fusion-fission energy systems evaluation.** Teofilo, V.L.; Aase, D.T.; Bickford, W.E. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jan 1980. Contract AC06-76RL01830. 355p. NTIS, PC A16/MF A01.

This report serves as the basis for comparing the fusion-fission (hybrid) energy system concept with other advanced technology fissile fuel breeding concepts evaluated in the Nonproliferation Alternative Systems Assessment Program (NASAP). As such, much of the information and data provided herein is in a form that meets the NASAP data requirements. Since the hybrid concept has not been studied as extensively as many of the other fission concepts being examined in NASAP, the provided data and information are sparse relative to these more developed concepts. Nevertheless, this report is intended to provide a perspective on hybrids and to summarize the findings of the rather limited analyses made to date on this concept.

31368 (PPPL—1614) **Conceptual design study of spheromak reactors.** Katsurai, M.; Yamada, M. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Jul 1980. Contract AM02-76CH03073. 37p. NTIS, PC A03/MF A01.

Preliminary design studies are carried out for a spheromak fusion reactor. Simplified circuit theory is applied to obtain characteristic relations among various parameters of the spheromak configuration for an aspect ratio A $\geq$ 1.6. These relations are used to calculate the parameters for the conceptual designs of three types of fusion reactor: (1) DT two-component, (2) DT ignited, and, (3) catalyzed DD ignited reactors. With a total wall loading of $\sim$ 4 MWm^{-2}, it is found that edge magnetic fields of only $\sim$ 4T (DT) and $\sim$ 9T (cat. DD) are required for ignited reactors of one-meter plasma (minor) radius with output powers in the gigawatt range. Assessment of various methods of generating reactor-grade spheromak plasmas is discussed briefly.

31369 (UCRL—50051-79-3) **Magnetic Fusion Energy Quarterly Report, July-September 1979.** Strack, J.R. (ed.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Feb 1980. Contract W-7405-ENG-48. 98p. NTIS, PC A05/MF A01.

The three main sections of this report are Confinement Systems, Development and Technology, and Applied Plasma Physics. Each of these sections is introduced by an overall statement of the goals and purposes of the groups reporting in it. As appropriate within each section, statements of the goals of individual programs and projects are followed by articles containing summaries of significant recent activity and descriptive text.

31370 (UCRL—50051-79-4) **Magnetic fusion energy. Quarterly report, October-December 1979.** Harrison, M.A.; McGregor, C.K. (eds.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Mar 1980. Contract W-7405-ENG-48. 55p. NTIS, PC A04/MF A01.

The information in each Quarterly is presented in the same sequence as in the Field Work Package Proposal and Authorization System (WPAS) submissions prepared for the US Department of Energy; the three main sections are Confinement Systems, Development and Technology, and Applied Plasma Physics. Each of these sections is introduced by an overall statement of the goals and purposes of the groups reporting in it. As appropriate within each section, statements of the goals of individual programs and projects are followed by articles containing summaries of significant recent activity and descriptive text. A fourth section, The Open Systems Mirror Fusion Program, will be included as appropriate to report on LLL's function as lead laboratory for that program.

31371 **Controlled nuclear fusion.** pp 385-396 of Energy in transition 1985-2010. Brooks, H.; Ginzton, E.L. (eds.). San Francisco, CA; W.H. Freeman and Co. (1980).

The committee's conclusions on fusion are: (1) Although the development of nuclear fusion faces considerable uncertainties, it should be pursued and reevaluated in 5 years. By that time, large scientific breakeven experiments in both magnetic and inertial confinement will have been attempted. More realistic engineering designs and guidance for further research on technological obstacles should then emerge naturally. (2) Principal attention should be directed first to the problems of pure fusion reactors, before the question of fusion-fission hybrids is considered. (3) The immature state of fusion R and D offers the opportunity to given attention to the environmental and safety characteristics in the earliest stages of design. Consideration of these characteristics is so important to decisions on major investments in fusion that the opportunity should not be wasted. (4) A small effort should be directed to fuel cycles other than deuterium-tritium. Pure deuterium has a much lower reaction rate but no critical tritium regeneration problem, and it wreaks less structural damage from high-energy neutrons. (5) High priority should be given to study and testing of structural materials, and assessments of their availability must be undertaken. (6) Research and development in nuclear fusion has enjoyed singularly fruitful international cooperation. This cooperation should be encouraged and extended to speed progress and reduce the cost to each individual country.

31372 **U.S. Department of Energy perspective on nonelectrical applications of fusion power.** Kintner, E.E. (Dept. of Energy, Washington, DC). *Trans. Am. Nucl. Soc.;* **33**: 210-211(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31373 **Fission or fusion.** Teller, E. (Stanford Unic., CA). *Trans. Am. Nucl. Soc.;* **33**: 214-215(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31374 **Fusion-fission fuel factory concept.** Bogart, S.L. (Science Applications, Inc., McLean, VA). *Trans. Am. Nucl. Soc.;* **33**: 215-216(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31375 **Hybrids based on tandem mirror.** Moir, R.W. (Univ. of Californica, Livermore). *Trans. Am. Nucl. Soc.;* **33**: 216-217(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

BLANKET ENGINEERING

31376 (ANL/FPP/TM—131, pp 7-82) **Fusion energy for alternate applications: development of a high temperature falling bed blanket system.** Harkness, S.D.; de Paz, J.F.; Stevens, H.C.; Hall, M.M.; Gohar, Y.A.; Kann, W.J. (Argonne National Lab., IL). Sep 1979.

In Fusion energy for alternate applications: development of a high temperature blanket for synthetic fuel production.

The high temperature falling bed conceptual design work has consisted of a coordinated effort in neutronics, materials science, thermal hydraulics and mechanical design. The neutronics work has aimed at scoping the effect of blanket dimensions, breeding materials, ceramic material and coolant choice on both tritium breeding capabilities and energy deposition into the high temperature region of the blanket. The materials science effort has concentrated on defining the selection of a particular ceramic material in terms of its resistance to radiation damage, in-reactor sintering, thermal cracking and induced radioactivity. The thermal hydraulic analysis has been concerned with evaluating the thermal performance of the system (defined in terms of the heat losses from the high temperature region), determining the temperature distribution throughout the falling bed region and surrounding structure, identifying potential problems associated with the flow of bulk solids and sizing the heat transfer system. The mechanical design work, to date, has defined how such a system might be constructed from the point of view of maintainability and structural support, and has devised a conceptual design for the associated energy conversion systems.

MAGNET COILS AND FIELDS

REFER ALSO TO CITATION(S) 31413

31377 (NRL-MR—4258) **Diverted plasma reversed field pinch.** Manheimer, W.M. (Naval Research Lab., Washington, DC (USA)). 16 Jul 1980. Contract AI01-76ET53020. 13p. NTIS, PC A02/MF A01.

This memo proposes a poloidal divertor as a method of reducing the strong plasma-wall interaction inherent in a reversed field pinch.

31378 (UCRL—83590) **Cryogenic system for the mirror fusion test facility.** VanSant, J.H.; Slack, D.S.; Nelson, R.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 26 Feb 1980. Contract W-7405-ENG-48. 7p. (CONF-800831—1). NTIS, PC A02/MF A01.

From Cryogenic processes and equipment conference; San Francisco, CA, USA (19 Aug 1980).

The Mirror Fusion Test Facility (MFTF), currently being constructed at the Lawrence Livermore Laboratory, has large superconducting magnets, cryopanels, and supporting cryogenic equipment that will comprise one of the world's largest liquid helium (LHe) systems. The facility will provide mirror magnetic confinement for experimental fusion plasmas that will be approximately the same physical size as if in a conceptual fusion reactor. The cryogenic system typifies the magnitude and makeup of systems that will be used in future magnetic fusion reactors. Here we describe the LHe cryopumping and magnet systems. Principal components include a 3300 W helium refrigerator, 30,000 L LHe storage, a 1.5 MW (2000 hp) refrigerator compressor, 1100 m^2 of cryopanels, and a 420 MJ superconducting magnet system. Design features, method of operation, thermal protection, and helium recovery operations are discussed.

31379 DEALS: a demountable superconducting magnet system for fusion reactors. Powell, J.R.; Hsieh, S.Y.; Danby, G. (Brookhaven National Lab., Upton, NY (USA)). *Cryogenics;* **20**: No. 2, 59-74(Feb 1980).

A new type of superconducting magnet system (DEALS) for large fusion reactors is described, in which the demountable superconducting coils would be made by joining together several prefabricated conductor sections. Conductor types, fabrication processes, and joining schemes are described. The magnetic forces on the conductors would be transmitted to an external room temperature support structure via low thermal conductivity bearing blocks. This reduces conductor tensile stresses to very low levels. Differential and mechanical thermal movements between the magnet coil and the external support structure would be accommodated by the use of moveable joints between magnet sections. These pressure type contact joints carry current during magnet operation, and do not carry tensile loads. Finite element analyses on the magnet and its support structure are presented together with analyses of magnet cooling requirements. Results of experiments on small movable pressure type joints at liquid helium temperatures are described. These indicate that adequately low joint losses should be achievable in large magnet systems. Current carrying capacity is not affected by relative motion, and friction coefficients are reasonable. Based on these results and the analyses, the DEALS concept appears feasible for fusion magnet systems.

31380 Passive generation of ambipolar potential barriers in a tandem mirror. Kesner, J. (Wisconsin Univ., Madison (USA). Dept. of Nuclear Engineering). *Comments Plasma Phys. Controlled Fusion;* **5**: No. 4, 123-130(Dec 1979).

The creation of a thermal barrier between the central cell and plug of a tandem mirror has been shown to produce a considerable improvement in tandem-mirror performance. A passive means of creating this barrier, by creating a mirror cell that lacks drift equilibrium and thereby cannot confine trapped ions is suggested. This approach is also shown selectively to remove high-Z ions, such as alphas, from the tandem-mirror central cell.

POWER SUPPLIES, ENERGY STORAGE

31381 Compensated pulsed alternator. Weldon, W.F.; Driga, M.D.; Woodson, H.H. (to Dept. of Energy). US Patent 4,200,831. 29 Apr 1980. Filed date 3 Aug 1978. 6p.

PAT-APPL-930,616.

This invention relates to an electromechanical energy converter with inertial energy storage. The device, a single phase, two or multi-pole alternator with stationary field coils, and a rotating armature is provided. The rotor itself may be of laminated steel for slower pulses or for faster pulses should be nonmagnetic and electrically nonconductive in order to allow rapid penetration of the field as the armature coil rotates. The armature coil comprises a plurality of power generating conductors mounted on the rotor. The alternator may also include a stationary or counterrotating compensating coil to increase the output voltage thereof and to reduce the internal impedance of the alternator at the moment of peak output. As the machine voltage rises sinusoidally, an external trigger switch is adapted to be closed at the appropriate time to create the desired output current from said alternator to an external load circuit, and as the output current passes through zero a self-commutating effect is provided to allow the switch to disconnect the generator from the external circuit.

31382 Isolated trigger pulse generator. Aaland, K. (to Dept. of Energy). US Patent 4,189,650. 19 Feb 1980. Filed date 24 Oct 1978. 8p.

PAT-APPL-954,252.

A trigger pulse generation system capable of delivering a multiplicity of isolated 100 kV trigger pulses with picosecond simultaneity is described.

HEATING AND FUELING SYSTEMS

REFER ALSO TO CITATION(S) 31267

31383 (IAEA-CN—38/Q-1) **Neutral beam injector research and development at ORNL and LBL/LLL in the United States.** Barber, G.C.; Blue, C.W.; Dagenhart, W.K. (Oak Ridge National Lab., TN (USA); California Univ., Berkeley (USA). Lawrence Berkeley Lab.; California Univ., Livermore (USA). Lawrence Livermore Lab.). 1980. Contract W-7405-ENG-26. 11p. (CONF-800707—16). NTIS, PC A02/MF A01.

From 8. international conference on plasma physics and controlled nuclear fusion research; Brussels, Belgium (1 Jul 1980).

Neutral beam injectors have been developed and applied successfully for injection heating of PLT and ISX-B plasmas. Present and near-future injection systems for PDX, ISX-C, DIII, MFTF, and TFTR are similar in principle, although scaled in beam energy, current, and pulse width to meet the machine requirements. In addition, as shown in recent calculations, an INTOR or ETF device will also utilize a positive-ion-based system with possible trade-offs between beam energy, current, and pulse length. That is, beam energies of about 100 keV are acceptable if the current and/or pulse length may be increased to appropriate values. Recent direct energy recovery experiments have shown that a positive-ion-based system can be expected to operate at an overall system efficiency of up to 50% if the beam energy is limited to a value below 75 keV/nucleon. For injection energy above 200 keV, a negative-ion-based neutral beam injector may be needed. In this paper we report the performance highlights of the existing ORNL and LBL/LLL beam systems and the necessary R and D needs for future high-efficiency, long-pulse beam systems.

31384 (ORNL/Sub—01617/16) **Development program for a 200 kW, CW, 28 GHz gyroklystron. Quarterly Report No. 16, January-March 1980.** Jory, H.; Conner, C.; Evans, S.; Moran, J.; Sayer, W.; Stone, D.; Symons, R.; Thomas, G. (Varian Associates, Palo Alto, CA (USA). Palo Alto Microwave Tube Div.). 1980. Contract W-7405-ENG-26. 38p. NTIS, PC A03/MF A01.

The objective of this program is to develop a microwave oscillator capable of producing 200 kW CW power output at 28 GHz. The use of the gyrotron or cyclotron resonance interaction is

being pursued. During this reporting period the basic testing of axisymmetric tube 5R2 was completed. It successfully operated in excess of 200 kW both in pulse and CW modes. The measured power output of 212 kW establishes a new world record for CW power generation at 28 GHz. Further tests with various output guide components simulating the EBTS load were made.

TRITIUM PROCESSING, ENVIRONMENT AND SAFETY

REFER ALSO TO CITATION(S) 30341, 30342

POWER CONVERSION SYSTEMS

31385 **Heat transport system.** Harkness, S.D. US Patent Application 094,993. [nd]. 20p.

A falling bed of ceramic particles receives neutron irradiation from a neutron-producing plasma and thereby transports energy as heat from the plasma to a heat exchange location where the ceramic particles are cooled by a gas flow. The cooled ceramic particles are elevated to a location from which they may again pass by gravity through the region where they are exposed to neutron radiation. Ceramic particles of alumina, magnesia, silica and combinations of these materials are contemplated as high-temperature materials that will accept energy from neutron irradiation. Separate containers of material incorporating lithium are exposed to the neutron flux for the breeding of tritium that may subsequently be used in neutron-producing reactions. The falling bed of ceramic particles includes velocity partitioning between compartments near to the neutron-producing plasma and compartments away from the plasma to moderate the maximum temperature in the bed.

INERTIAL CONFINEMENT TECHNOLOGY

REFER ALSO TO CITATION(S) 30940, 31062, 31063, 31064, 31065, 31066, 31069, 31408

31386 (ANL-HIF—80-1) **Heavy ion fusion program. Annual progress report, October 1, 1978-September 30, 1979.** (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 49p. NTIS, PC A03/MF A01.

Some conceptual design concepts and program plans are outlined. Some experimental work on the preaccelerator and the independently-briefly phased low beta rf linac cavities is described. (MOW)

31387 (ANL-HIF—80-2) **Heavy ion fusion program. Semi-annual progress report, October 1, 1979-March 30, 1980.** (Argonne National Lab., IL (USA)). 1980. Contract W-31-109-ENG-38. 40p. NTIS, PC A03/MF A01.

HIF activity at ANL during FY 1980 has been primarily concentrated on conceptual design work, and on initial tests of the independently-phased rf acceleration cavities. Calculations for near-term foil-heating experiments were carried out, and a specific cost-effective synchrotron (Beam Development Facility) plan was developed. Program logics were further refined, and some conceptual reactor issues were addressed.

31388 (LA-UR—80-1927) **Antares automatic beam alignment system.** Appert, Q.; Swann, T.; Sweatt, W.; Saxman, A. (Los Alamos Scientific Lab., NM (USA)). 1980. Contract W-7405-ENG-36. 12p. (CONF-800719—8). NTIS, PC A02/MF A01.

From International symposium of the Society of Photo-Optical Instrumentation Engineers; San Diego, CA, USA (28 Jul 1980).

Antares is a 24-beam-line CO_2 laser system for controlled fusion research, under construction at Los Alamos Scientific Laboratory (LASL). Rapid automatic alignment of this system is required prior to each experiment shot. The alignment requirements, operational constraints, and a developed prototype system are discussed. A visible-wavelength alignment technique is employed that uses a telescope/TV system to view point light sources appropriately located down the beamline. Auto-alignment is accomplished by means of a video centroid tracker, which determines the off-axis error of the point sources. The error is nulled by computer-driven, movable mirrors in a closed-loop system. The light sources are fiber-optic terminations located at key points in the optics path, primarily at the center of large copper mirrors, and remotely illuminated to reduce heating effects.

31389 (LBL—10914) **Heavy ion fusion half-year report, October 1, 1979-March 31, 1980.** (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1980. Contract W-7405-ENG-48. 40p. NTIS, PC A03/MF A01.

Major elements of the program in the first half of Fiscal Year 1980 included: (1) characterization of the 1 amp, 1 MV, 2 μs beam after acceleration through one pulsed drift tube; (2) observation of current and energy spikes at the onset of the beam pulse occasioned by the unusually long transit-time (~ 1 μsec) of the mass 133 ions across the diode gap; (3) completion of the full system, comprising of source and three drift-tubes, in February 1980; (4) development of new beam diagnostic probes for high-intensity ion beams; and (5) a major re-direction of the design effort on the Induction Linac Test Bed to bring costs, based on R/D funds that include overhead, down from the 40 million system (described in LBL PUB-5031) to the canonical 25 million.

31390 (SAND—80-0463C) **Versatile 0.5 TW electron beam facility for power conditioning studies of large rare-gas/halide lasers.** Ramirez, J.J. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 4p. (CONF-800640—5). NTIS, PC A02/MF A01.

From 14. pulse power modulator symposium; Orlando, FL, USA (3 Jun 1980).

Rare-gas/halide lasers which are being developed for Inertial Confinement Fusion will require large area, low impedance electron beam drivers. A wide range of electron beam parameters are being considered for future systems in an effort to optimize the overall system design. A number of power conditioning issues must be investigated in order to obtain a better understanding of the various trade-offs involved in making such optimizations. The RAYITO electron beam accelerator is being designed and built at Sandia National Laboratories and will be used for such investigations. It will be capable of operating in either a 2 or 4 ohm configuration at 1 MV, 50 ns or 0.8 MV, 200 ns. Design details for RAYITO are presented in this paper. Experiments planned for this facility are also discussed.

31391 (SAND—80-7029) **Magnetic insulation in triplate and coaxial vacuum transmission lines. Report PIFR-1009.** Di Capua, M.; Pellinen, D.G. (Physics International Co., San Leandro, CA (USA)). Aug 1980. Contract AC04-76DP00789. 223p. NTIS, PC A10/MF A01.

An experimental investigation was made of magnetically insulated transmission lines for use in an electron beam fusion accelerator. The magnetically insulated vacuum transmission lines would transfer the power pulses from many modules to a single diode region or multiple diodes to generate currents on the order of 100 MA. This approach may allow present limits on power flow through dielectric vacuum interfaces to be overcome. We have investigated symmetric parallel plate (triplate) transmission lines with a wave impedance of 24 Ω and a spacing of 1.9 cm, and coaxial transmission lines (coax) with a wave impedance of 42 Ω and a spacing of 2.9 cm.

31392 (UCRL—84008) **Evolution of shiva laser alignment systems.** Boyd, R.D. (California Univ., Livermore (USA). Lawrence Livermore National Lab.). Jul 1980. Contract W-7405-ENG-48. 9p. (CONF-800719—9). NTIS, PC A02/MF A01.

From International symposium of the Society of Photo-Optical Instrumentation Engineers; San Diego, CA, USA (28 Jul 1980).

The Shiva oscillator pulse is preamplified and divided into twenty beams. Each beam is then amplified, spatially filtered, directed, and focused onto a target a few hundred micrometers in size producing optical intensities up to 10^{16}W/cm^2. The laser was designed and built with three automatic alignment systems: the oscillator alignment system, which aligns each of the laser's three oscillators to a reference beamline; the chain input pointing system, which points each beam into its respective chain; and the chain output pointing, focusing and centering system which points, centers and focuses the beam onto the target. Recently the alignment of the laser's one hundred twenty spatial filter pinholes was also automated. This system uses digitized video images of back-illuminated pinholes and computer analysis to determine current positions. The offset of each current position from a desired center point is then translated into stepper motor commands and the pinhole is moved the proper distance. While motors for one pinhole are moving, the system can digitize, analyze, and send commands to other motors, allowing the system to efficiently align several pinholes in parallel.

31393 **Measurements of short-pulse backscatter from a gas target.** Mayer, F.J.; Busch, G.E.; Kinzer, C.M.; Estabrook, K.G. (KMS Fusion, Inc., Ann Arbor, Michigan 48106). DE-AC08-78DP4003D;W-7405-ENG-48. *Phys. Rev. Lett.;* **44**: No. 23, 1498-1501(9 Jun 1980).

Measurements are reported of short-pulse (100 psec), 1.06-μm laser backscatter from a high-pressure nitrogen gas target. Spectral measurements clearly show the expected Brillouin red shift. The backscatter fraction saturated at ~ 40% at 2 x 10^{15} W/cm^2 and what appears to be multiple Brillouin scattering in a long—gradient-length plasma is observed.

31394 **Vacuum aperture isolator for retroreflection from laser-irradiated target.** Benjamin, R.F.; Mitchell, K.B. (to Dept. of Energy). US Patent 4,194,813. 25 Mar 1980. Filed date 13 Oct 1978. 4p.

PAT-APPL-951,203.

The disclosure is directed to a vacuum aperture isolator for retroreflection of a laser-irradiated target. Within a vacuum chamber are disposed a beam focusing element, a disc having an aperture and

a recollimating element. The edge of the focused beam impinges on the edge of the aperture to produce a plasma which refracts any retroreflected light from the laser's target.

31395 Effect of target purity on laser-produced plasma expansion. Ehler, W.; Begay, F.; Tan, T.H.; Hayden, J.; McLeod, J. (Los Alamos Scientific Lab., NM (USA)). *J. Phys., D (London);* **13**: No. 2, L29-L32(14 Feb 1980).

The effects of target surface impurities on the laser-produced plasma were studied by means of Thomson ion spectrograms and time-of-flight measurements of the plasma ions. Hydrocarbons were believed to be the most likely surface impurity. Consequently, polyethylene was used to characterise an impure target. For comparison, pure targets (5 to 20 ppm impurities) of C, Ti, and Ta and a standard quality Ti target were used. The fastest Csup(z+) ions from the plasma expansion using a polyethylene target had the same peak velocity. When the hydrogen impurity was removed from a carbon target, the fastest Csup(z+) ions had an energy proportional to their charge in agreement with the isothermal expansion model. Also, the presence of hydrogen affected the lateral transport of the plasma.

31396 Manipulator for rotating and examining small spheres. Weinstein, B.W.; Willenborg, D.L. (to Dept. of Energy). US Patent 4,188,118. 12 Feb 1980. Filed date 17 May 1978. 6p.

PAT-APPL-906,815.

A manipulator which provides fast, accurate rotational positioning of a small sphere, such as an inertial confinement fusion target, which allows inspecting of the entire surface of the sphere is described. The sphere is held between two flat, flexible tips which move equal amounts in opposite directions. This provides rolling of the ball about two orthogonal axes without any overall translation. The manipulator may be controlled, for example, by an x- and y-axis driven controlled by a mini-computer which can be programmed to generate any desired scan pattern.

31397 Interferogram reduction and interpretation as applied to the optical analysis of a laser fusion system. Viswanathan, V.K. (Los Alamos Scientific Lab., NM); Sollid, J.E.; Hall, W.S.; Liberman, I.; Lawrence, G. *Am. Soc. Test. Mater., Spec. Tech. Publ.;* 98-106(1978).

The 10 kJ Eight-Beam CO_2 Laser Fusion System, currently under construction at Los Alamos Scientific Laboratory (LASL), has approximately 100 optical elements per beam. The nominal system is diffraction limited and degradations in performance are caused primarily by imperfect components and alignment errors. Consequently, analysis and predictions for the system are very much dependent on the proper description of the imperfect components. The approach taken at LASL has been to characterize the components interferometrically. An example of this procedure, using an actual interferogram of a manufactured component, will be presented and the various limitations will be discussed.

COMPONENT DEVELOPMENT AND MATERIALS TESTING

REFER ALSO TO CITATION(S) 30342, 30876, 30900, 31266

31398 (EPRI-AP—1433) **Assessment of titanium alloys for fusion reactor first-wall and blanket applications. Final report.** Jones, R.H.; Leonard, B.R. Jr.; Johnson, A.B. Jr. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jun 1980. Contract AC06-76RL01830. 86p. NTIS, PC A05/MF A01.

The results of this study show that Ti-70A and Ti-6Al-4V are very radiation resistent. Void swelling, which is the dominant form of radiation damage in 316SS and other candidate materials, is either non-existent or negligible for titanium alloys at temperatures below 500°C. Radiation damage was limited to the generation of dislocations in Ti-70A and Ti-6Al-4V and precipitation in Ti-6Al-4V which will strengthen and possibly cause some embrittlement. Both Ti-70A and Ti-6Al-4V were resistant to helium embrittlement and in comparison with data of others were more resistant than 316SS.

31399 (HEDL-SA—2140-FP) **Measurements and evaluations of nuclear data to support early design needs of the FMIT facility.** Johnson, D.L.; Mann, F.M.; Schenter, R.E. (Hanford Engineering Development Lab., Richland, WA (USA)). Apr 1980. Contract AC14-76FF02170. 23p. (CONF-800551—17). NTIS, PC A02/MF A01.

From Symposium on neutron cross sections from 10 - 50 MeV; Upton, NY, USA (12 May 1980).

The Fusion Materials Irradiation Test (FMIT) facility is currently being designed for use in the study of neutron radiation effects in fusion reactor materials. This facility will make use of the intense source of high energy neutrons produced by a beam of 35 MeV deuterons incident upon a thick target of liquid lithium. In the forward direction, the neutron spectrum from this source peaks near 14 MeV as in a fusion device. However, the neutron energy spectrum in the FMIT facility will be broader and there will be a significant number of neutrons emitted with energies up to about 30 MeV. A small fraction will be emitted with even higher energies, up to a maximum of 50 MeV. Since ENDF/B evaluations of neutron-cross section data extend only to 20 MeV (with little data above 15 MeV) there is a great need for neutron data from 15 to 50 MeV for the FMIT facility. Furthermore, nuclear reaction cross sections induced by deuterons up to 35 MeV are a vital part of design and operation considerations, and are even less well understood than the neutron data. The time scale of the design of the FMIT facility has been so rapid that it has precluded large amounts of new nuclear data coming from outside the project. This report outlines work carried out within the FMIT project to supply the most immediate nuclear data needs. Nuclear data needs for remaining design considerations and for long-term operational uses will be discussed.

31400 (HEDL-SA—2141-FP) **Thick target neutron yields and spectra from the Li(d,xn) reaction at 35 MeV.** Johnson, D.L.; Mann, F.M.; Watson, J.W.; Brady, F.P.; Ullmann, J.L.; Romero, J.L.; Castaneda, C.M.; Zanelli, C.I.; Wyckoff, W.G. (Hanford Engineering Development Lab., Richland, WA (USA); California Univ., Davis (USA)). May 1980. Contract AC14-76FF02170. 13p. (CONF-800551—16). NTIS, PC A02/MF A01.

From Symposium on neutron cross sections from 10 - 50 MeV; Upton, NY, USA (12 May 1980).

Measurements were performed using a 35 MeV deuteron beam from the isochronous cyclotron at the University of California at Davis. Data were obtained using the time-of-flight technique with an NE213 liquid scintillator. One set of measurements was used to observe the neutron spectrum from ~ 1 MeV to ~ 50 MeV, the maximum kinematically allowed energy. Observation angles were from 0° to 150° with emphasis on forward angles. Spectral data below ~ 1.5 MeV had poor accuracy. It was felt that a significant fraction of the neutron yield might lie at still lower energies, therefore a second set of measurements was performed to investigate the spectra to as low an energy as possible. Additional measurements were performed with a target enriched in the isotope ^{6}Li replacing the natural lithium target used in previous measurements. The main advantage of a ^{6}Li target is that the maximum kinematically allowed neutron energy is only about 38 MeV, hence reducing shielding requirements. The experiments, preliminary results, and future needs will be described.

31401 (HEDL-SA—2148) **Cross sections required for FMIT dosimetry.** Gold, R.; McElroy, W.N.; Lippincott, E.P.; Mann, F.M.; Oberg, D.L.; Roberts, J.H.; Ruddy, F.H. (Hanford Engineering Development Lab., Richland, WA (USA)). 2 May 1980. Contract AC14-76FF02170. 56p. (CONF-800551—18). NTIS, PC A04/MF A01.

From Symposium on neutron cross sections from 10 - 50 MeV; Upton, NY, USA (12 May 1980).

The Fusion Materials Irradiation Test (FMIT) facility, currently under construction, is designed to produce a high flux of high energy neutrons for irradiation effects experiments on fusion reactor materials. Characterization of the flux-fluence-spectrum in this rapidly varying neutron field requires adaptation and extension of currently available dosimetry techniques. This characterization will be carried out by a combination of active, passive, and calculational dosimetry. The goal is to provide the experimenter with accurate neutron flux-fluence-spectra at all positions in the test cell. Plans have been completed for a number of experimental dosimetry stations and provision for these facilities has been incorporated into the FMIT design. Overall needs of the FMIT irradiation damage program delineate goal accuracies for dosimetry that, in turn, create new requirements for high energy neutron cross section data. Recommendations based on these needs have been derived for required cross section data and accuracies.

31402 Comparative study of the performance and economics of advanced and conventional structural materials in fusion systems. Abdou, M.A.; El-Derini, Z. (Georgia Inst. of Tech., Atlanta (USA). School of Nuclear Engineering). *J. Nucl. Mater.;* **85**: No. 86, 57-64(Dec 1979).

From 1. topical meeting on fusion reactor materials; Miami Beach, FL (29 - 31 Jan 1979).

The impact of the neutron wall load as well as the lifetime and operating temperature of the structural material on tokamak reactor economics was investigated and a comparative study of stainless steel and vanadium alloys was performed. In order to limit the fractional increase in the cost of energy due to the plant downtime, t, for replacement of the structural material to delta, the structure lifetime, T, must be greater than t/delta where T and t are in years. Economically attractive tokamak reactors produce a neutron wall load of 3-4 MW/m^2 for 3000 MW thermal power. The cost of energy is optimized by an operating temperature of the structural material in the wall/blanket in the range 475-500°C for stainless steel and 620-660°C for vanadium alloys. The gain in electric power due to higher operating temperatures is not sufficient to offset the penalty in the capital cost associated with the use of vanadium alloys as compared to stainless steel. Therefore, the vanadium alloy must exhibit a significant lifetime advantage over stainless steel to be economically competitive. The magnitude of this advantage is par-

ticularly sensitive to the plant downtime and the reference lifetime of stainless steel as well as the extent to which the refractory alloy has to be used in the heat transport system.

31403 (UCID—18717) **DYNAVAC: a transient-vacuum-network analysis code.** Deis, G.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Jul 1980. Contract W-7405-ENG-48. 39p. NTIS, PC A03/MF A01.

This report discusses the structure and use of the program DYNAVAC, a new transient-vacuum-network analysis code implemented on the NMFECC CDC-7600 computer. DYNAVAC solves for the transient pressures in a network of up to twenty lumped volumes, interconnected in any configuration by specified conductances. Each volume can have an internal gas source, a pumping speed, and any initial pressure. The gas-source rates can vary with time in any piecewise-linear manner, and up to twenty different time variations can be included in a single problem. In addition, the pumping speed in each volume can vary with the total gas pumped in the volume, thus simulating the saturation of surface pumping. This report is intended to be both a general description and a user's manual for DYNAVAC.

31404 (ORNL/tr—4666) **Use of a moving limiter in large tokamaks and fusion reactors.** Mirnov, S.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). Jun 1980. Translation source information not available . 16p. NTIS, PC A02/MF A01.

The conditions arising in the plasma-wall boundary region are considered. The operation of the limiter is analyzed. Attention is given to a moving, absorbing limiter consisting of balls that in conjunction with magnetic islands, may fulfill the function of a divertor - exhausting the hydrogen flux and, perhaps, also the helium.

31405 Thermal response of TNS graphite liner and first wall materials. Bowers, D.A. (McDonnell Douglas Astronautics Co., St. Louis, MO (USA)). *J. Nucl. Mater.;* **85**: No. 86, 209-213(Dec 1979).

From 1. topical meeting on fusion reactor materials; Miami Beach, FL (29 - 31 Jan 1979).

Operating temperatures of the plasma chamber for the General Atomic Company TNS (The Next Step) fusion reactor are defined in this study. Specifically, the thermal response of protective graphite liners (tiles) and two wall materials are assessed for normal PGFR (Power Generating Fusion Reactor) plasma heat loads. Results indicate that graphite tile temperatures will be acceptable for use on the inboard wall, and that either Inconel or titanium chamber walls exhibit satisfactory temperatures for structurally feasible wall designs.

31406 Ceramics for applications in fusion systems. Clinard, F.W. Jr. (Los Alamos Scientific Lab., NM (USA)). *J. Nucl. Mater.;* **85**: No. 86, 393-404(Dec 1979).

From 1. topical meeting on fusion reactor materials; Miami Beach, FL (29 - 31 Jan 1979).

Six critical applications for ceramics in fusion systems are reviewed, and structural and electrical problem areas discussed. Fusion neutron radiation effects in ceramics are considered in relation to fission neutron studies. A number of candidate materials are proposed for further evaluation.

31407 Tokamak reactors and structural materials. Conn, R.W. (Wisconsin Univ., Madison (USA). Dept. of Nuclear Engineering). *J. Nucl. Mater.;* **85**: No. 86, 9-16(Dec 1979).

From 1. topical meeting on fusion reactor materials; Miami Beach, FL (29 - 31 Jan 1979).

A summary is given of the status of the tokamak as a reactor concept and the relationship between first wall and blanket materials behavior and reactor design.

31408 Critical environmental considerations for particle-beam-driven ICF reactor materials. Cook, D.L.; Sweeney, M.A. (Sandia Labs., Albuquerque, NM (USA)). *J. Nucl. Mater.;* **85**: No. 86, 127-131(Dec 1979).

From 1. topical meeting on fusion reactor materials; Miami Beach, FL (29 - 31 Jan 1979).

The magnitude of the chamber gas pressure required for beam propagation along low-density plasma channels in a particle-beam-driven ICF reactor (> 6 KPa) results in a first wall environment very different from that expected either in a laser-driven reactor or a magnetic confinement reactor. The gas greatly attenuates the energy in X-rays and debris ions from the pellet, shielding the chamber wall from severe transient thermal loads. The presence of the gas is also a major consideration in power transmission and in mitigation of diode damage. In this paper, basic design information for gas-filled particle beam reactors is presented and an assessment of the critical materials environments is made. The nature of the materials-related problems is discussed and the areas in which research is most needed are specified.

31409 Surface damage and sputtering of ATJ graphite as candidate armor plate material for TFTR under D^+ bombardment. Das, S.K.; Kaminsky, M.; Tishler, R. (Argonne National Lab., IL (USA)); Cecchi, J. (Princeton Univ., NJ (USA). Plasma Physics Lab.). *J. Nucl. Mater.;* **85**: No. 86, 225-230(Dec 1979).

From 1. topical meeting on fusion reactor materials; Miami Beach, FL (29 - 31 Jan 1979).

Experiments have been conducted to determine surface damage and total sputtering yields of ATJ graphite (a candidate armor plate material) caused by D^+ ion irradiation at 40-, 60-, and 120- keV for fluxes close to those expected to reach the armor plate during the operation of neutral beam injectors used for the Tokamak Fusion Test Reactor (TFTR). The irradiations for surface damage studies were conducted both in the pulsed mode and in the continuous mode. Scanning electron microscopy of irradiated surfaces revealed surface damage in the form of ridges and grooves for both pulsed and continuous irradiation. Total sputtering yields for ATJ graphite samples which reached surface temperatures characteristic for given beam power depositions are given for 40-, 60-, and 120-keV D^+ irradiations at normal incidence.

31410 Impact of hydrogen in a fusion reactor environment on titanium alloys. Davis, J.W.; Smith, D.L. (McDonnell Douglas Astronautics Co., St. Louis, MO (USA); Argonne National Lab., IL (USA)). *J. Nucl. Mater.;* **85**: No. 86, 71-76(Dec 1979).

From 1. topical meeting on fusion reactor materials; Miami Beach, FL (29 - 31 Jan 1979).

The impact of hydrogen in a fusion reactor on a titanium first wall and blanket structure has been investigated. Hydrogen is of concern in titanium because the combination of hydrogen isotopes in a fusion reactor and titanium's high affinity for hydrogen has the potential for producing hydrogen embrittlement and increasing the tritium inventory. The solubility of hydrogen in titanium depends upon a number of variables, chief of which is the type and amount of phase present, (alpha, beta, or alpha-beta). In this study the influence of alloying elements on phase stability and hydrogen solubility was investigated. The effects of three major sources of hydrogen were examined: (1) Hydrogen produced via neutron transmutation reactions, (2) deuterium and tritium from the plasma chamber, and (3) tritium from the breeding material or coolant. Results indicate that under the conditions studied hydrogen from transmutation reactions does not raise the hydrogen concentration significantly above the level currently allowed in commercial alloys. However, significant amounts of deuterium and tritium can be absorbed in the first wall at the higher gas pressures encountered during the refueling cycle. The tritium concentration anticipated with lithium or lithium oxide present, result in low tritium concentrations in titanium structures whereas tritium pressures anticipated for a lithium-lead breeding blanket may result in substantial tritium concentrations in a titanium structure.

31411 Structural performance of plasma chamber materials for a power generating tokamak. Delaney, M.J.; Cramer, B.A.; Trachsel, C.A. (McDonnell Douglas Astronautics Co., St. Louis, MO (USA)). *J. Nucl. Mater.;* **85**: No. 86, 165-169(Dec 1979).

From 1. topical meeting on fusion reactor materials; Miami Beach, FL (29 - 31 Jan 1979).

This paper compares Inconel 625, titanium 6242S, and 316 stainless steel as candidate plasma chamber first wall structural materials. Factors which have a significant effect on plasma chamber design are identified. Results are based on studies conducted for the Power Generating Fusion Reactor (PGFR) having a peak plasma power of 650 MW. The analyses use unirradiated material properties. Properties important in the design are discussed. The effect of material properties and load conditions on life of the plasma chamber is also addressed.

31412 Compatibility of structural materials with fusion reactor coolant and breeder fluids. DeVan, J.H. (Oak Ridge National Lab., TN (USA)). *J. Nucl. Mater.;* **85**: No. 86, 249-256(Dec 1979).

From 1. topical meeting on fusion reactor materials; Miami Beach, FL (29 - 31 Jan 1979).

Fusion reactors are characterized by a lithium-containing blanket, a heat transfer medium that is integral with the blanket and first wall, and a heat engine that couples to the heat transfer medium. A variety of lithium-containing substances have been identified as potential blanket materials, including molten lithium metal, molten LiF-BeF_2, Pb-Li alloys, and solid ceramic compounds such as Li_2O. Potential heat transfer media include liquid lithium, liquid sodium, molten nitrates, water, and helium. Each of these coolants and blankets requires a particular set of chemical and mechanical properties with respect to the associated reactor and heat engine structural materials. This paper discusses the materials factors that underlie the selection of workable combinations of blankets and coolants. It also addresses the materials compatibility problems generic to those blanket-coolant combinations currently being considered in reactor design studies.

31413 Structures, insulators and conductors for large superconducting magnets. Fickett, F.R.; Reed, R.P. (National Bureau of Standards, Boulder, CO (USA)); Dalder, E.N.C. (Department of Energy, Washington, DC (USA)). *J. Nucl. Mater.;* **85**: No. 86, 353-360(Dec 1979).

From 1. topical meeting on fusion reactor materials; Miami Beach, FL (29 - 31 Jan 1979).

As the size of superconducting magnet systems increases, the structural aspects become of increasing importance. Because the stresses increase rapidly with size and field, magnets of the type proposed for new devices will be largely structure. We are engaged in a program to acquire low temperature mechanical and physical property data on a wide range of materials. The present status of this data base is reviewed and results from our test program are described. We have placed emphasis on the austenitic stainless steels as the primary structural material, although data have also been acquired on a few aluminum alloys. Particular stress has been placed on the fracture characteristics of both the base metal and weldments where appropriate. Achieving a good match between weld and base metal at 4 K is proving to be a difficult task. Several industrial fiberglass-epoxy laminates of fixed composition have been produced as a result of this program. These materials, G10 CR, G11 CR and G11 CR(BF) have been tested at 4 K and the results are presented. Recent measurements on the effect of stress and fatigue on matrix materials for superconductor stabilization are also briefly reviewed. A new handbook of data on the properties of structural materials for superconducting magnet systems is described.

31414 Materials/environment interactions in the Tokamak Fusion Test Reactor (TFTR). Fixler, S.Z. (Grumman Aerospace Corp., Bethpage, NY (USA)). *J. Nucl. Mater.;* **85**: No. 86, 241-246(Dec 1979).

From 1. topical meeting on fusion reactor materials; Miami Beach, FL (29 - 31 Jan 1979).

The effects of the thermal and stress environments on the TFTR liners and limiters are evaluated. Material thermal responses, thermal gradients, thermal stress/strain distributions, and fatigue life predictions are given for several power densities over the range of cycles required to reach equilibrium. Results of parametric limiter blade cooling studies are presented, including the effects of active and radiation cooling on the resultant temperature levels. The response of graphite liners to neutral-beam strikes of various intensities and pulse lengths was investigated. The analysis included the response of continuous vs tiled configurations, and single vs double wall concepts.

31415 Experimental evaluation of the primary damage process - neutron energy effects. Goland, A.N. (Brookhaven National Lab., Upton, NY (USA)). *J. Nucl. Mater.;* **85**: No. 86, 453-461(Dec 1979).

From 1. topical meeting on fusion reactor materials; Miami Beach, FL (29 - 31 Jan 1979).

Experimental evaluation of the neutron energy dependence of the primary damage state depends upon a number of theoretical concepts. This state can only be observed after low- or perhaps ambient-temperature, low-fluence irradiations. The primary recoil energy spectrum, which determines the character of the displacement cascades, can be calculated if dosimetry has provided an accurate neutron spectrum. A review of experimental results relating neutron-energy effects shows that damage energy cross section has often been a reliable correlation parameter for primary damage state experiments. However, the forthcoming emphasis on higher irradiation temperatures, more complex alloys and microstructural evolution has fostered a search for additional meaningful correlation parameters.

31416 Differential neutron cross section for free interstitial production in copper. Goldstone, J.A.; Parkin, D.M.; Simpson, H.M. (Los Alamos Scientific Lab., NM (USA)). *J. Nucl. Mater.;* **85**: No. 86, 617-620(Dec 1979).

From 1. topical meeting on fusion reactor materials; Miami Beach, FL (29 - 31 Jan 1979).

Free interstitials produced by monoenergetic neutrons were monitored by changes in Young's modulus of a vibrating foil specimen. These changes can be related to the number of pinners on dislocations which depends on the number of defects produced. The pinning rate is compared with displacement cross section calculations and agrees with the Norgett-Robinson-Torrens (NRT) model. Electron irradiations on the same sample yield estimates of the free interstitial production cross section to be approx. 1% of the NRT cross section.

31417 Integral tests of nuclear activation cross sections for Be (d,n) sources, Esub(d) = 14-40 MeV. Greenwood, L.R.; Heinrich, R.R. (Argonne National Lab., IL (USA). Chemical Engineering Div.). *J. Nucl. Mater.;* **85**: No. 86, 473-377(Dec 1979).

From 1. topical meeting on fusion reactor materials; Miami Beach, FL (29 - 31 Jan 1979).

Thirty-one neutron cross sections have been extended to 44 MeV for dosimetry application at high energy accelerator sources. Integral testing in Be(d,n) fields at Esub(d) = 14, 16, and 40 MeV shows that 22 cross sections are accurate to within +- 10%. An example of routine flux-spectral unfolding and damage analysis is shown with an error analysis. Cross section needs are discussed.

31418 Review of lifetime analyses for tokamaks. Harkness, S.D. (Argonne National Lab., IL (USA)); Cramer, B. (McDonnell Douglas Astronautics Co., St. Louis, MO (USA)). *J. Nucl. Mater.;* **85**: No. 86, 135-145(Dec 1979).

From 1. topical meeting on fusion reactor materials; Miami Beach, FL (29 - 31 Jan 1979).

System studies have shown that economic fusion power can best be achieved from the use of long lived components. The stresses generated in a first wall module are a complex function of its geometry, the chosen structural material and the tokamak burn cycle characteristics. A means of applying ASME Code Case 1592 to preliminary design has been established. Methods of incorporating some of the material property changes expected from irradiation are discussed. Cyclic stresses imposed by tokamak operation are expected to cause fatigue related properties to govern the life of the structure. Stress assisted bubble growth is also discussed. This may be the critical mechanism in establishing the creep rupture life of a fusion first wall component.

31419 Remote segmentation approach on TFTR. Young, N.E. (Ebasco Services, Inc., New York, NY); Lontai, L.M. (Princeton Univ., NJ). *Trans. Am. Nucl. Soc.;* **33**: 929(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31420 Design considerations for remote maintenance of ETF. Sager, P.H. Jr.; Hager, E.R. (General Atomic Co., San Diego, CA). *Trans. Am. Nucl. Soc.;* **33**: 930(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

31421 Remotely operated shield door for the Culham conceptual tokamak reactor. Guthrie, J.A.S. (Associated Nuclear Services, Surrey, England); Mitchell, J.T.D. *Trans. Am. Nucl. Soc.;* **33**: 936-938(1979). (CONF-791103—).

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

GENERAL AND MISCELLANEOUS

MANAGEMENT

31422 (BNL—51163) Staff roster for 1979: Energy Technology programs. (Brookhaven National Lab., Upton, NY (USA)). Dec 1979. Contract AC02-76CH00016. 57p. NTIS, PC A04/MF A01.

Brief resumes of personnel involved in BNL Energy Technology programs are presented. (RWR)

31423 (BNL—51166) Staff roster for 1979: National Center for Analysis of Energy Systems. (Brookhaven National Lab., Upton, NY (USA)). Jan 1980. Contract AC02-76CH00016. 70p. NTIS, PC A04/MF A01.

This publication is a compilation of resumes from the current staff of the National Center for Analysis of Energy Systems. The Center, founded in January 1976, is one of four areas within the Department of Energy and Environment at Brookhaven National Laboratory. The emphasis of programs at the Center is on energy policy and planning studies at the regional, national, and international levels, involving quantitative, interdisciplinary studies of the technological, economic, social, and environmental aspects of energy systems. To perform these studies the Center has assembled a staff of experts in the areas of science, technology, economics planning, health and safety, information systems, and quantitative analysis.

31424 (DOE/AD—0010/10) Selected DOE Headquarters publications, October 1979. (Department of Energy, Washington, DC (USA). Director of Administration). Jul 1980. 61p. NTIS, PC A04/MF A01.

This publication provides cumulative listings of and an index to DOE headquarters publications issued since October 1979. Three types of headquarters publications are included: publications dealing mainly with program and policy that are attributed to and issued by headquarters organizations, reports prepared by contractors to describe research and development work they have performed for the Department, and environmental development plans and impact statements. Such items as pamphlets, fact sheets, bulletins, newsletters, telephone directories, headquarters publications issued under the DOE-tr and CONF codes, technical reports from the Jet Propulsion Laboratory and NASA issued under DOE/JPL and DOE/NASA

codes, and weekly/monthly reports of the Energy Information Administration are not included. (RWR)

31425 (DOE/CR—0015) **Cost and schedule control systems criteria for contract performance measurement. Implementation guide.** (Department of Energy, Washington, DC (USA). Office of the Controller). May 1980. 109p. NTIS, PC A06/MF A01.

This document provides uniform guidance for implementation of the DOE Order 2250.1, Cost and Schedule Control Systems Criteria (CSCSC) for Contract Performance Measurement. Its purpose is to assist both DOE and contractor representatives in fulfilling their responsibilities for meeting CSCSC requirements. Compliance with the contractual requirements for work definition, cost and schedule control, and performance reporting should provide increased assurance that a contractor's progress is sufficiently visible to indicate status reliably and to provide the basis for timely and meaningful management decisions. 8 figures. (RWR)

MATHEMATICS AND COMPUTERS

REFER ALSO TO CITATION(S) 30230, 31214, 31328

31426 (ANL—80-64) **Solution of the general nonlinear programming problem with subroutine VMCON.** Crane, R.L.; Hillstrom, K.E.; Minkoff, M. (Argonne National Lab., IL (USA)). Jul 1980. Contract W-31-109-ENG-38. 40p. NTIS, PC A03/MF A01.

The solution of the general nonlinear programing problem by means of a subroutine called VMCON is described. VMCON uses an algorithm that solves a sequence of positive-definite quadratic programing subproblems. Each solution determines a direction in which a one-dimensional minimization is performed. In developing this code, changes in the original implementation were made to make the program easier to use and maintain and to incorporate some recently developed LINPACK subprograms. The current implementation contains extensive in-line documentation; an interface subroutine, VMCON1, with a simplified calling sequence; and print options to aid the user in interpreting results. 2 figures.

31427 (BNL—27929) **Asymptotic distribution of a histogram density estimator.** Kim, B.K.; Van Ryzin, J. (Memorial Univ. of Newfoundland, St. John's (Canada); Brookhaven National Lab., Upton, NY (USA)). Jun 1980. Contract AC02-76CH00016. 16p. (CONF-800658—1). NTIS, PC A02/MF A01.

From Colloquium on nonparametric statistical inference; Budapest, Hungary (22 Jun 1980).

Two theorems on the asymptotic distribution of a histogram density estimator based on randomly determined spacings introduced by Van Ryzin in 1973 are stated and proved. One theorem gives conditions for the pointwise asymptotic normality of the density estimator for points in the support of the density at which the density is continuously differentiable. A second theorem gives conditions for the pointwise asymptotic normality of the density estimator with a faster convergence rate for points in the support of the density at which the density is twice continuously differentiable. The results are used to compare the relative asymptotic efficiencies of the histogram estimator with the kernal method of density estimation.

31428 (BNL—28070) **LIFT: a nested decomposition algorithm for solving lower block triangular linear programs. Report AMD-859.** Ament, D.; Ho, J.; Loute, E.; Remmelswaal, M. (Erasmus Univ., Rotterdam (Netherlands); Brookhaven National Lab., Upton, NY (USA); Universite Catholique de Louvain, Louvain-la-Neuve (Belgium)). Jun 1980. Contract AC02-76CH00016. 26p. (CONF-800687—1). NTIS, PC A03/MF A01.

From Workshop on large-scale linear programming; Laxenburg, Austria (2 Jun 1980).

Nested decomposition of linear programs is the result of a multilevel, hierarchical application of the Dantzig-Wolfe decomposition principle. The general structure is called lower block-triangular, and permits direct accounting of long-term effects of investment, service life, etc. LIFT, an algorithm for solving lower block triangular linear programs, is based on state-of-the-art modular LP software. The algorithmic and software aspects of LIFT are outlined, and computational results are presented. 5 figures, 6 tables. (RWR)

31429 (COO—2280-11) **Finite sparse matrix techniques.** Bareiss, E.H.; de Peniza, C.M. (Northwestern Univ., Evanston, IL (USA). Technological Inst.; Universidad Central de Venezuela, Caracas). Nov 1979. Contract AS02-76ER02280. 102p. NTIS, PC A06/MF A01.

A unified theory of finite sparse matrix techniques based on a literature search and new results is presented. It is intended to aid in computational work and symbolic manipulation of large sparse systems of linear equations. The theory relies on the bijection property of bipartite graph and rectangular Boolean matrix representation. The concept of perfect elimination matrices is extended from the classification under similarity transformations to that under equivalence transformations with permutation matrices. The reducibility problem is treated with a new and simpler proof than found in the literature. A number of useful algorithms are described. The minimum deficiency algorithms are extended to the new classification, where the latter required a different technique of proof. 13 figures, 7 tables.

31430 (COO—2280-38) **OBV methods.** Beauwens, R. (Northwestern Univ., Evanston, IL (USA). Technological Inst.; Brussels Univ. (Belgium)). Aug 1979. Contract AS02-76ER02280. 37p. NTIS, PC A03/MF A01.

The properties of OB relaxation of Varga iterative methods are investigated, with particular emphasis on diagonal relaxation. Generalizations of the results of Beauwens and Quenon [SIAM J. Numer. Anal., 13, 615-643 (1976)] are presented, and their relations with the works of Axelsson and Gustafsson are indicated. Finally, the combination of this formalism with the Axelsson-Gustafsson analysis to enlarge the scope of the latter is illustrated.

31431 (COO—2383-0071) **Software systems research. Annual report, November 16, 1979-November 15, 1980.** Gear, C.W.; Watanabe, D.S. (Illinois Univ., Urbana (USA). Dept. of Computer Science). 1980. Contract AS02-76ER02383. 9p. NTIS, PC A02/MF A01.

Progress made during the last year in the following areas is briefly summarized: ODEs with highly oscillatory solutions, ODEs with discontinuities, multirate methods for ODEs, efficient low-accuracy methods for ODEs, iterative methods and sparse techniques for implicit ODE methods, method of lines with variable space mesh, methods for parallel and/or network architectures, software and hardware tools, and other results. This report is administrative in nature, and is not meant to present detailed results. (RWR)

31432 (MHSMP—80-31) **Wang 700 program to calculate a one-sided confidence interval for the parameter of a Poisson distribution.** Ashcraft, R.W. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, TX (USA)). Jul 1980. Contract AC04-76DP00487. 12p. NTIS, PC A02/MF A01.

The Poisson distribution and its use in risk analysis are discussed. A method is given to estimate the parameter p and derive a one-sided confidence interval for p; since the calculation is tedious, a Wang 700 program has been written.

31433 (ORNL/CSD/TM—125) **Critical evaluation of readily available software for spectral analysis of discrete time series data.** Rust, B.W. (Oak Ridge National Lab., TN (USA)). Jul 1980. Contract W-7405-ENG-26. 40p. NTIS, PC A03/MF A01.

This report is designed to be a beginner's guide to the use of current readily available software for the Fourier analysis of real-time series. It uses an example test problem to explain the basic concepts and to describe the use of some of the most readily accessible subroutines and includes evaluations of those subroutines.

31434 (PCTR—53-78) **Monograph on the use of the multivariate Gram Charlier series Type A.** Hatayodom, T.; Heydt, G. (Purdue Univ., Lafayette, IN (USA). School of Electrical Engineering). Jan 1978. Contract AS02-77ET29102. 50p. (TR-EE—78-5). NTIS, PC A03/MF A01.

The Gram-Charlier series in an infinite series expansion for a probability density function (pdf) in which terms of the series are Hermite polynomials. There are several Gram-Charlier series - the best known is Type A. The Gram-Charlier series, Type A (GCA) exists for both univariate and multivariate random variables. This monograph introduces the multivariate GCA and illustrates its use through several examples. A brief bibliography and discussion of Hermite polynomials is also included. 9 figures, 2 tables.

31435 (SAND—79-2476) **Survey of numerical methods for ordinary differential equations.** Watts, H.A. (Sandia National Labs., Albuquerque, NM (USA)). May 1980. Contract AC04-DP00789. 40p. (CONF-800347—2). NTIS, PC A03/MF A01.

From SIAM international conference on electric power problems: the mathematical challenge; Seattle, WA, USA (18 Mar 1980).

Significant progress has been made in recent years in the numerical solution of initial-value problems for ordinary differential equations. Algorithmic and software advances have been substantial, leading to code improvements in the areas of overall efficiency, reliability, robustness (the ability to diagnose and handle unexpected difficulties or misuse of the codes), and convenience (ease of use). Good codes are now readily available, and difficult nonstiff as well as many stiff problems are currently being solved rather routinely. Stiff problems remain relatively expensive to solve, and current stiff solvers are somewhat less reliable than nonstiff counterparts; however, it is expected that the next generation of ODE software will substantially improve on some of these drawbacks. This survey paper briefly outlines some of the best methods being used, identifies some software, and mentions some of the current research directions.

Particular emphasis is given to methods and codes aimed at solving stiff problems. 95 references.

31436 (SAND—80-0538/3) **Remote hard copy. Volume 3. Systems programming manual.** Simons, R.W. (Sandia National Labs., Albuquerque, NM (USA)). Mar 1980. Contract AC04-76DP00789. 36p. NTIS, PC A03/MF A01.

The software used to operate and maintain the remote hard copy is described. All operating software that runs in the NOVA minicomputers is covered as are various utility and diagnostic programs used for creating and checking this software. 2 figures.

31437 (SAND—80-0655) **Interval analysis approach to rank determination in linear least squares problems.** Manteuffel, T.A. (Sandia National Labs., Albuquerque, NM (USA)). Jun 1980. Contract AC04-76DP00789. 39p. NTIS, PC A03/MF A01.

The linear least-squares problem $Ax \simeq b$ has a unique solution only if the matrix A has full column rank. Numerical rank determination is difficult, especially in the presence of uncertainties in the elements of A. This paper proposes an interval analysis approach. A set of matrices A/sup I/ is defined that contains all possible perturbations of A due to uncertainties; A/sup I/ is said to be rank deficient if any member of A/sup I/ is rank deficient. A modification to the Q-R decomposition method of solution of the least-squares problem allows a determination of the rank of A/sup I/ and a partial interval analysis of the solution vector x. This procedure requires the computation of R^{-1}. Another modification is proposed which determines the rank of A/sup I/ without computing R^{-1}. The additional computational effort is $O(N^2)$, where N is the column dimension of A. 4 figures.

31438 (SAND—80-1140C) **Centrality of paths and vertices in a graph: cores and pits.** Slater, P.J. (Sandia National Labs., Albuquerque, NM (USA)). 1980. Contract AC04-76DP00789. 11p. (CONF-800558—1). NTIS, PC A02/MF A01.

From 4. international conference on the theory and applications of graphs; Kalamazoo, MI, USA (6 May 1980).

As criteria for the selection of a site at which to locate a facility in a graph or network, measures of the suitability of a vertex v include the eccentricity e(v), the distance d(v), and, when the graph is a tree, the branch weight bw(v). A vertex at which function e, d, or bw is minimized is called a center, a median, or a (branch weight) centroid, respectively. For a tree T the functions e, d, and bw are convex functions on vertex set V(T); and, in general, they measure how central a vertex is relative to the other vertices. The nature of the facility to be constructed (such as a pipeline) could necessitate selecting a structure (such as a path) rather than just a point at which to locate the facility. Similarly, the facility may be required to service structures or areas within the graph. Functions e, d, and bw can be applied to paths P in the graph and (minimum) paths P for which e(P), d(P), and bw(P) are minimized are called path centers, cores, and spines, respectively. With emphasis on these central paths, central structures are examined. 3 figures.

31439 (SAND—80-1171) **RATFOR: user's guide.** Wampler, B.E. (Sandia National Labs., Albuquerque, NM (USA)). Jun 1980. Contract AC04-76DP00789. 67p. NTIS, PC A04/MF A01.

RATFOR is a preprocessor for Fortran that allows the programmer to use structured control statements and free form input. This manual describes a version of RATFOR developed at Sandia National Laboratories that has a number of enhancements over the original version developed at Bell Laboratories.

31440 (UCRL—84566) **Archival memory system (AMS) specification.** Michael, G.A. (California Univ., Livermore (USA). Lawrence Livermore National Lab.). 1980. Contract W-7405-ENG-48. 12p. (CONF-800387—1). NTIS, PC A02/MF A01.

From 4. IEEE workshop on mass storage; Denver, CO, USA (16 Mar 1980).

The technical specification for an archival memory system is described. A phased acquisition leading ultimately to a very large ($> 10^{18}$ bits) on-line memory facility is envisioned. 8 figures.

31441 (UIUCDCS-R—80-1006) **Method and initial stepsize selection in multistep ODE solvers.** Gear, C.W. (Illinois Univ., Urbana (USA). Dept. of Computer Science). Feb 1980. Contract AS02-76ER02383. 38p. NTIS, PC A03/MF A01.

This report examines a technique for determining three groups of information needed to start an automatic ODE solver: the initial stepsize, estimates of the largest eigenvalue, and high-accuracy estimates of the solution at several nearby points. The stepsize estimate allows an efficient start for multistep or one-step methods; the eigenvalue allows the code to decide which class of methods to use (although it is recommended that the initial steps should always be taken with a nonstiff method); the additional function values allow a high-order multistep method be used from the start.

31442 (UIUCDCS-R—80-1014) **Unified modified divided difference implementation of Adams and BDF fomulas.** Gear, C.W. (Illinois Univ., Urbana (USA). Dept. of Computer Science). Mar 1980. Contract AS02-76ER02383. 27p. NTIS, PC A03/MF A01.

The representation of both full variable-step and fixed-leading-coefficient implementations of BDF formulas using the modified divided differences normally associated with Adams' formulas is developed. Simple recursion relationships for the coefficients are derived. The technique permits a simple, compact implementation of variable-step and fixed-leading-coefficient forms of blended formulas.

31443 **WKB method for systems of integral equations.** Berk, H.L.; Pfirsch, D. (University of California, Lawrence Livermore Laboratory, Livermore CA 94550). W-7405-ENG-48. *J. Math. Phys. (N.Y.);* **21**: No. 8, 2054-2066(Aug 1980).

The WKB theory for vector systems of integral equations is developed herein. A variational technique is used to derive the equations for the WKB amplitudes in x-space or its dual k-space. Compact, explicit solutions are obtained in one dimension. When a solution breaks down at a turning point, the dual-space representation can be used to derive the connection formulas between WKB solutions. These connection formulas are equivalent to the rules of the Furry method. The Furry method is used to show how general golbal-dispersion relations can be constructed.

31444 **Tidy drawings of trees.** Wetherell, C.; Shannon, A. (Lawrence Livermore Lab., CA). *IEEE Transactions of Software Engineering;* **SE-5**: No. 5, 514-520(Sep 1979).

Trees are extremely common data structures, both as internal objects and as models for program output. But it is unusual to see a program actually draw trees for visual inspection. Although part of the difficulty lies in programing graphics devices, most of the problem arises because naive algorithms to draw trees use too much drawing space and sophisticated algorithms are not obvious. Two naive tree drawers, are surveyed, aesthetics for tidy trees are formalized, and two algorithms that draw tidy trees are described. One of the algorithms may be shown to require the minimum possible paper width. Along with the algorithms proper, the reasoning behind the algorithm development is discussed. 9 figures

31445 (ORNL/CSD/TM—120) **Revised user's manual for the hierarchical cluster analysis code DENDRO.** Larson, N.M.; Begovich, C.L. (Oak Ridge National Lab., TN (USA)). [nd]. Contract W-7405-ENG-26. 76p. NTIS, PC E03/MF $3.50.

The computer code DENDRO is a multipurpose hierarchical cluster analysis program containing many data-normalization choices, metric options, and clustering criteria. This report is intended to be an update of the user's manual for DENDRO, including equations describing each normalization, metric, and clustering option, results of application of DENDRO to various types of data sets, operating instructions, and sample input-output. 6 figures, 5 tables.

INFORMATION HANDLING

31446 (BNL-NCS—28103) **Role of the National Nuclear Data Center in the field of nuclear waste transmutation.** Rose, P.F. (Brookhaven National Lab., Upton, NY (USA)). 1980. Contract AC02-76CH00016. 21p. (CONF-800743—8). NTIS, PC A02/MF A01.

From International conference on nuclear waste transmutation; Austin, TX, USA (22 Jul 1980).

This report discusses the role of The National Nuclear Data Center (NNDC), formerly the National Neutron Cross Section Center. The NNDC collates and analyzes nuclear physics information for basic and applied research scientists. The NNDC performs functions that are characteristic of an information analysis center, namely bibliographic searches, data compilation, and critical appraisal of available information. Such compilations and searches are of unique importance for investigators in the field of nuclear waste transmutation. In addition, the NNDC issues publications, provides technical support to its sponsors, and conducts seminars on important topics. A primary concern of the NNDC is the timely production and revision of reference nuclear data. The NNDC coordinates the Cross Section Evaluation Working Group (CSEWG), a cooperative effort of over 20 laboratories, and the Nuclear Data Network (NDN), a group of US Nuclear Data Centers involved in the study of nuclear structure. The NNDC also interfaces with similar groups outside the United States in activities contributing to documented computerized reference data files. The Department of Energy has established the NNDC as the Center to service requests from the research community for bibliographic and data retrievals for neutron, charged particle, nuclear structure, and radioactive decay data.

31447 (DOE/EIA—0205(80/2Q)) **Energy Information Referral Directory: second quarter 1980.** (Department of Energy, Washington, DC (USA). Energy Information Administration). 1980. 161p. NTIS, PC A08/MF A01.

This directory provides the name, address, and phone number of various energy information offices within the DOE and other Federal agencies. Entries are arranged by broad subject categories which are further subdivided by sub-categories. Each entry presents the name of the office, the address, the main contact person, and a summary of the office's primary activities. There is a comprehensive subject index to the entries as well as a name index. In addition, the publication contains several appendices in which DOE Regional Energy Information Centers, state energy offices, DOE commercialization-resource managers and DOE research and development and field facilities are listed. Charts illustrate the DOE and the EIA organizational structure. A cumulative updated edition is issued quarterly.

31448 (LBL—10811) **NRCC software catalog. Volume 1.** (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Feb 1980. Contract W-7405-ENG-48. 108p. NTIS, PC A06/MF A01.

The software library is organized into the principal scientific program areas of graphics, chemical kinetics, macromolecular science, numerical methods, physical organic chemistry, quantum chemistry, statistical mechanics, and crystallography. The text part of each catalog entry consists of a brief summary of the purpose, method and other attributes of the program. Further information is provided in the full program write-up. Literature references are given in some instances. The names of the authors, and in some cases place of origin of the program are given. Most of the programs coming from outside have undergone some modification for use on the CDC7600 and therefore the NRCC takes partial responsibility for maintaining them. Difficulties encountered in using programs should be brought to the attention of NRCC staff, not the original authors. A list of available files follows the program origin. The machine designators CDC, IBM, VAX have been added to distinguish the several machine specific source versions that exist for various programs. Note that all files are in either source (card image) or printed output (line image) format. The NRCC does not distribute object or CDC Update files. The support level and distribution status are indicated for each program using the classification code described earlier.

31449 (LBL—11034) **Development of a political science thesaurus.** Cerny, B.A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 5 Jun 1980. Contract W-7405-ENG-48. 59p. NTIS, PC A04/MF A01.

The procedures used in developing a political science thesaurus for use by the DOE Technical Information Center and the Executive Office of the President Information Center are described. The classification scheme for terms in the political science thesaurus is given in an appendix, but only a one-page sample of the thesaurus itself is shown. (RWR)

31450 (ORNL/CSD/TM—121) **Selected exploratory data analysis topics concerning data validation with examples from the FPC Form-4 system.** Kane, V.E.; Begovich, C.L. (Oak Ridge National Lab., TN (USA)). Jul 1980. Contract W-7405-ENG-26. 119p. NTIS, PC 8.50/MF $3.50.

This report illustrates several exploratory methods that may be useful in assessing the general quality of data within a data base. Ideally, statistical analyses are directed toward specific, well-formulated objectives; such is not the case here. The analyses mainly serve to illustrate characteristics of the data. These procedures can be expected to help formulate questions concerning the validity of the data; answers to these questions will generally be derived from the data collection system. The FPC Form-4 data base is used to illustrate the exploratory procedures. Comments and questions concerning the Form-4 system are given only to illustrate the exploratory processes. Any implications to the Form-4 data can only be made by individuals familiar with the entire data collection process. 9 figures, 29 tables. (RWR)

31451 (SAND—80-0530) **Who dunnit? A crash course in style for Sandia authors.** Lopez, L.S. (Sandia National Labs., Albuquerque, NM (USA)). Jul 1980. Contract AC04-76DP00789. 65p. NTIS, PC A04/MF A01.

This report presents a short course for the busy engineer-scientist who wants to write reports that meet minimum standards of modern technical writing. The text stresses some cardinal rules of good writing: personal pronouns, strong verbs, active voice, clear expression, and avoidance of jargon and noun modifiers.

CORPORATE INDEX

In the Corporate Index, report literature is indexed using the name of the organization or institution responsible for issuing the report. Headings are provided for all report literature and for published literature for which a corporate approach is especially desirable, e.g., symposium and conference proceedings.

Each entry under a corporate heading gives the report title and the volume and abstract numbers. Report numbers, if applicable, are given in parentheses at the end of the entry.

DOE Energy Information Data Base: Corporate Author Entries (TID-4585) is used in the standardization of corporate entries. TID-4585 is available for purchase from the National Technical Information Service (NTIS), U. S. Department of Commerce, Springfield, Virginia 22161.

A

Aeronautical Research Associates of Princeton, Inc., NJ (USA)
Modeling of dry deposition of SO_2 and sulfate aerosols. Final report, 5:31126 (EPRI-EA—1452)

Aerospace Corp., El Segundo, CA (USA)
Solar thermal power systems. Summary report, 5:30427 (DOE/CS/21036—01)

Aerospace Corp., El Segundo, CA (USA). Eastern Technical Div.
Examination of commercial aviation operational energy conservation strategies, 5:30810 (DOE/CS/2184—2)

AeroVironment, Inc., Pasadena, CA (USA)
Definitive generic study of augmented horizontal axis wind energy systems. Executive summary. Final report, 5:30589 (SERI/TR—98003-1)

Air Force Ballistic Missile Office, Norton AFB, CA (USA)
Reentry-vehicle flight testing and recovery techniques. Paper AIAA-80-1455, 5:31025 (SAND—80-1648C)

Air Products and Chemicals, Inc., Allentown, PA (USA)
Cryogenic methane separation/catalytic hydrogasification process analysis. Final report, 5:30100 (FE—3044-T12)

Alabama Univ., Huntsville (USA). Kenneth E. Johnson Environmental and Energy Center
SPS energy conversion and power management workshop. Final report, 5:30419 (DOE/CS/34218—T1)

Allied-General Nuclear Services, Barnwell, SC (USA)
Fleet servicing facilities for servicing, maintaining, and testing rail and truck radioactive waste transport systems: functional requirements, technical design concepts and options cost estimates and comparisons, 5:30262 (ORNL/SUB—79/13866/1)
On-line monitoring of plutonium in mixed uranium-plutonium solutions, 5:30327 (AGNS—35900-CONF-61)
Spent-fuel disassembly and canning programs at the Barnwell Nuclear Fuel Plant (BNFP), 5:30260 (AGNS—35900-CONF-63)

Altas Corp., Santa Cruz, CA (USA)
Use of solar energy for the cooling of buildings, 5:30473 (CONF-780249—)

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Glacial geology of the West Tensleep Drainage Basin, Bighorn Mountains, Wyoming, 5:31244 (IS-T—879)
Yttrium-rich side of the yttrium-niobium-titanium system, 5:30862 (IS-T—908)

AN SSSR, Moscow. Fizicheskij Inst.
Cosmological models of the universe with rotation of time's arrow, 5:31259 (SLAC-Trans—0192)
Mass formula for mesons and baryons, 5:31286 (SLAC-Trans—0191)

Applied Energy Systems, Inc., Cape Canaveral, FL (USA)
Assessment of the potential for heat recovery and load leveling on refrigeration systems. Volume 2. Detailed findings. Final report, 5:30797 (EPRI-EM—1348(Vol.2))

Applied Technology Corp., Norman, OK (USA)
Fire safety of LPG in marine transportation. Final report, 5:30199 (DOE/EV/06020—T1)

Argonne National Lab., IL (USA)
Advances in nondestructive evaluation methods for inspection of refractory concretes, 5:30931 (CONF-800393—1)
Assessment of the atmospheric effects of a satellite power system, 5:31121 (CONF-791204—39)
Corrosion and mechanical behavior of materials for coal gasification applications, 5:30064 (ANL—80-5)
Development of high temperature secondary Li-Al/FeS/sub x/ batteries at Argonne National Laboratory, 5:30733 (CONF-800324—4)
Ecological and biomedical effects of effluents from near-term electric vehicle storage battery cycles, 5:31116 (ANL/ES—90)
Environmental assessment of DOE transportation programs, 5:31122 (CONF-800334—17)
Fusion energy for alternate applications: development of a high temperature blanket for synthetic fuel production, 5:30343 (ANL/FPP/TM—131)
Grain ethanol as a petroleum substitute: a perspective, 5:30402 (ANL/SPG—9)
Heavy ion fusion program. Annual progress report, October 1, 1978-September 30, 1979, 5:31386 (ANL-HIF—80-1)
Heavy ion fusion program. Semi-annual progress report, October 1, 1979-March 30, 1980, 5:31387 (ANL-HIF—80-2)
High-performance batteries for electric-vehicle propulsion and stationary energy storage. Progress report, October 1978-September 1979, 5:30732 (ANL—79-94)
Influence of ultrasonic vibrations on short-range order in α-aluminum bronzes, 5:30868 (ANL-Trans—1190)
Lagrangian three-dimensional finite-element formulation for the nonlinear fluid-structural response of reactor components, 5:30643 (ANL—80-26)
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Methods of chemical analysis used to characterize battery materials, 5:30966 (ANL—80-41)
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Molten carbonate fuel cell programs in the United States, 5:30789 (CONF-800324—3)
Neutron total and scattering cross sections of ^{6}Li in the few MeV region, 5:31312 (ANL/NDM—52)
Nuclear instrumentation system operating experience and nuclear instrument testing in the EBR-II, 5:30675 (CONF-800366—3)

Numerical modeling of fluidized-bed combustor, 5:31078 (ANL-CT—78-4)
Refractory metal particles in refractory inclusions in the Allende meteorite, 5:31260 (CONF-800361—2)
Regeneration of sulfated limestone from FBCs. Annual report, October 1978-September 1979, 5:30159 (ANL/CEN/FE—79-13)
Reliability, energy, and cost effects of wind-powered generation integrated with a conventional generating system, 5:30584 (ANL/AA—17)
Solution of the general nonlinear programming problem with subroutine VMCON, 5:31426 (ANL—80-64)
Some questions on the Coriolis force, the structure of rotational states and the IBM, 5:31305 (CONF-800213—13)
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The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processses applied to, the subject term.

Index entries are selected to indicate the important ideas and concepts presented in a document, rather than words that may appear in the text. Within the available thesaurus terms, the most probable or logical place to look for typical information is selected. "See references" are included to guide users from synonymous terms or phrases to the descriptor selected as a subject heading for the concept. (e.g. Pipeline Quality Gas see HIGH BTU GAS). "See also references" are used to indicate where to find references to subject concepts that are narrower, broader, or related to a particular subject heading. To complete an exhaustive search of a given subject, all such headings should be reviewed.

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	5:31227	DOE/ET/13557—14
AC02-79EV10040	Institute of Ecology, Indianapolis, IN (USA)	
	5:31110	DOE/EV/10040—1
	5:31139	DOE/EV/10040—2
AC02-79EV10097	Brown Univ., Providence, RI (USA)	
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AC02-79EV10142	New Mexico Univ., Albuquerque (USA). Dept. of Economics	
	5:30603	DOE/EV/10142—1
AC02-79EV10281	Aspen Inst. for Humanistic Studies, Boulder, CO (USA)	
	5:31112	DOE/EV/10281—T1
AC02-80CS23337	Purdue Univ., Lafayette, IN (USA)	
	5:30796	DOE/CS/23337—1
AC02-80ET17019	General Electric Co., Schenectady, NY (USA). Energy Systems Programs Dept.	
	5:30791	DOE/ET/17019—1
AC02-80EV10327	Beth Israel Hospital, Boston, MA (USA). Div. of Nuclear Medicine	
	5:31187	DOE/EV/10327—1
AC03-76ET12056	Stanford Univ., CA (USA). Petroleum Research Inst.	
	5:30170	DOE/ET/12056—T1
AC03-76ET12058	Getty Oil Co., Ventura, CA (USA)	
	5:30172	DOE/SAN/1188—4
AC03-76SF00515	AN SSSR, Moscow. Fizicheskij Inst.	
	5:31259	SLAC-Trans—0192
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AC03-78CS40167	Johns-Manville Corp., Denver, CO (USA)	
	5:30815	DOE/CS/40167—T1
AC03-78CS52184	Aerospace Corp., El Segundo, CA (USA). Eastern Technical Div.	
	5:30810	DOE/CS/2184—2
AC03-78SF01802	Gary Energy Corp., Englewood, CO (USA)	
	5:30173	DOE/SF/01802—39
AC03-79ET23047	Exxon Research and Engineering Co., Linden, NJ (USA). Advanced Energy Systems Labs.	
	5:30373	DOE/ET/23047—4
AC03-79PE70090	Booz, Allen and Hamilton, Inc., Bethesda, MD (USA)	
	5:30166	DOE/PE/70090—T1
AC03-79SF10760	Institute of Gas Technology, Chicago, IL (USA)	
	5:30180	DOE/SF/10760—2
AC04-76DP00053	Mound Facility, Miamisburg, OH (USA)	
	5:30219	MLM—2736
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AC04-76DP00487	Mason and Hanger-Silas Mason Co., Inc., Amarillo, TX (USA)	
	5:31109	MHSMP—80-32
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AC04-76DP00613	Bendix Corp., Kansas City, MO (USA)	
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AC04-76DP00656	**General Electric Co., St. Petersburg, FL (USA). Neutron Devices Dept.**	
	5:30742	GEPP-OP—497
AC04-76DP00789	**Department of Energy, Laramie, WY (USA). Laramie Energy Research Center**	
	5:30104	SAND—80-0847C
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AC04-76DP03533	**Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant**	
	5:30278	RFP—3079
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AC04-76EV01013	**Lovelace Foundation for Medical Education and Research, Albuquerque, NM (USA). Inhalation Toxicology Research Inst.**	
	5:31200	LMF—68
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AC04-78ET23060	**Lockheed Palo Alto Research Labs., CA (USA)**	
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AC04-78ET23061	**Mobil Tyco Solar Energy Corp., Waltham, MA (USA)**	
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AC04-78ET23064	**Solar Power Corp., Woburn, MA (USA)**	
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AC04-79ET23002	**Pennsylvania Univ., Philadelphia (USA)**	
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AC04-76DP000789	**Sandia National Labs., Albuquerque, NM (USA)**	
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AC04-DP00789	**Sandia National Labs., Albuquerque, NM (USA)**	
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AC05-76ET53036	**Texas Univ., Austin (USA). Dept. of Physics**	
	5:31342	DOE/ET/53036—18
AC05-76EV05268	**Southwest Research Inst., San Antonio, TX (USA)**	
	5:30561	DOE/EV/05268—T1
AC05-78EV06020	**Applied Technology Corp., Norman, OK (USA)**	
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AC05-79ET60004	**Decision Focus, Inc., Palo Alto, CA (USA)**	
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AC06-76ET53027	**Mathematical Sciences Northwest, Inc., Bellevue, WA (USA)**	
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AC06-76EV01831	**Battelle Pacific Northwest Labs., Richland, WA (USA)**	
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AC06-76RL01830	**Battelle Columbus Labs., OH (USA)**	
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AC06-76RL01857	**United Nuclear Industries, Inc., Richland, WA (USA)**	
	5:30700	UNI—1532
AC06-77RL01030	**Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations**	
	5:30250	RHO-CD—519
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	5:30309	RHO-BWI-SA—49
	5:30310	RHO-BWI-SA—50
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AC06-77RL01049	**Oregon Inst. of Tech., Klamath Falls (USA). Geo-Heat Utilization Center**	
	5:30564	DOE/RL/01049—T7
AC07-76ID01540	**Styrelsen foer Teknisk Utveckling, Stockholm (Sweden)**	
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AC07-76ID01570	Idaho National Engineering Lab., Idaho Falls (USA)	
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	5:30680	EGG/LTR-LO—87-80-134
	5:30681	EGG-SSDC—5088
	5:30703	CONF-800723—18
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AC07-78ID01570	Idaho National Engineering Lab., Idaho Falls (USA)	
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AC07-79ID01675	Exxon Nuclear Idaho Co., Inc., Idaho Falls (USA)	
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AC08-76NV00410	San Diego State Univ., CA (USA)	
	5:31091	DOE/NV/00410—T1
AC08-76NV00597	Westinghouse Electric Corp., Pittsburgh, PA (USA). Advanced Energy Systems Div.	
	5:30267	CONF-800607—79
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AC08-76NV01183	EG and G, Inc., Las Vegas, NV (USA). Energy Measurements Group	
	5:31132	EGG—1183-1755
AC08-78DP40006	Avco-Everett Research Lab., Inc., Everett, MA (USA)	
	5:31062	DOE/DP/40006—1
AC08-78DP40054	Sanders Associates, Inc., Nashua, NH (USA). Defensive Systems Div.	
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AC08-79BC10003	CER Corp., Las Vegas, NV (USA)	
	5:30203	DOE/BC/10003—9
AC09-76SR00001	Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.	
	5:30230	DP-MS—80-29
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AC09-78ET35900	Allied-General Nuclear Services, Barnwell, SC (USA)	
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AC11-76PN00292	Duquesne Light Co., Shippingport, PA (USA)	
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AC13-76GJ01664	Los Alamos Scientific Lab., NM (USA)	
	5:30226	GJBX—138(80)
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AC14-76FF02170	Battelle Columbus Labs., OH (USA)	
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AC15-76CL02395	Westinghouse Electric Corp., Madison, PA (USA). Advanced Reactors Div.	
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AC19-78ET13067	Department of Energy, Bartlesville, OK (USA). Bartlesville Energy Technology Center	
	5:30171	DOE/ET/13067—60
AC19-79BC10008	Stubbs Overbeck and Associates, Inc., Houston, TX (USA)	
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AC19-80BC10171	Texas A and M Univ., College Station (USA). Dept. of Biochemistry and Biophysics	
	5:30198	DOE/BC/10171—1
AC21-77-ET10415	Minnick (L.J.), Inc., Plymouth Meeting, PA (USA)	
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AC22-80PC30094	Massachusetts Inst. of Tech., Cambridge (USA)	
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AC22-80PC30141	TRW, Inc., Redondo Beach, CA (USA)	
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AI01-76CS31037	National Aeronautics and Space Administration, Huntsville, AL (USA). George C. Marshall Space Flight Center	
	5:30367	DOE/NASA/TM—78286
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	5:30526	DOE/NASA/CR—161481
AI01-76CS51011	National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center	
	5:30840	DOE/NASA/1011—31
AI01-76ET12548	Jet Propulsion Lab., Pasadena, CA (USA)	
	5:30154	JPL-PUBL—80-49
AI01-76ET20191	Naval Research Lab., Washington, DC (USA)	
	5:30728	NRL-MR—4267
AI01-76ET53020	Naval Research Lab., Washington, DC (USA)	
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AI01-77CS51044	National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center	
	5:30839	DOE/NASA/1004—9
AI01-77ET10769	General Electric Co., Philadelphia, PA (USA). Space Sciences Lab.	
	5:30785	DOE/NASA/0052—79/1
AI01-79ET20305	Boeing Engineering and Construction Co., Seattle, WA (USA)	
	5:30586	DOE/NASA/0002—80/2(Vol.2)
AI01-79ET21036	Aerospace Corp., El Segundo, CA (USA)	
	5:30427	DOE/CS/21036—01
AI08-76DP00539	Nevada Univ., Reno (USA)	
	5:31147	EMSL-LV—0539-34
AM02-76CH03073	Princeton Univ., NJ (USA). Plasma Physics Lab.	
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AM06-76RL02130	Atlantic Richfield Hanford Co., Richland, WA (USA)	
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AP01-79EV10014	Bolt, Beranek, and Newman, Inc., Cambridge, MA (USA)	
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AS01-77ET32017	George Washington Univ., Washington, DC (USA)	
	5:30618	DOE/ET/32017—T1
AS01-78CS34218	Alabama Univ., Huntsville (USA). Kenneth E. Johnson Environmental and Energy Center	
	5:30419	DOE/CS/34218—T1
AS02-76-ER04504	Columbia Univ., Palisades, NY (USA). Lamont-Doherty Geological Observatory	
	5:31248	DOE/ER/04054—4
AS02-76ER02197	Los Alamos Scientific Lab., NM (USA)	
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AS02-76ER02280	Northwestern Univ., Evanston, IL (USA)	
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AS02-76ER02383	Illinois Univ., Urbana (USA). Dept. of Computer Science	
	5:31431	COO—2383-0071
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AS02-76ER03158	Cornell Univ., Ithaca, NY (USA)	
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AS02-76ER03230	Brandeis Univ., Waltham, MA (USA). Dept. of Physics	
	5:31271	DOE/ER/03230—T1
AS02-76ER03244	Carnegie-Mellon Univ., Pittsburgh, PA (USA)	
	5:31294	COO—3244-76
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AS02-76ER03533	Syracuse Univ., NY (USA). Dept. of Physics	
	5:31283	COO—3533-166
AS02-76ET53051	Wisconsin Univ., Madison (USA)	
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AS02-76EV00910	Minnesota Univ., St. Paul (USA). Coll. of Veterinary Medicine	
	5:31198	DOE/EV/00910—52
AS02-76EV01199	Illinois State Water Survey, Urbana (USA)	
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AS02-76EV01332	Minnesota Univ., Minneapolis (USA)	
	5:31169	DOE/EV/01322—132
AS02-76EV02486	Case Western Reserve Univ., Cleveland, OH (USA). Dept. of Radiology	
	5:31186	COO—2486-369-1
AS02-76EV02777	Michigan Research Center, Okemos (USA)	
	5:31194	COO—2777-04
AS02-76EV03501	Rochester Univ., NY (USA). School of Medicine and Dentistry	
	5:31206	COO—3501-14
AS02-76EV13573	Yale Univ., New Haven, CT (USA). Dept. of Geology and Geophysics	
	5:31163	COO—3573-30
AS02-77DP40079	Yale Univ., New Haven, CT (USA)	
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AS02-77ER04440	Illinois Inst. of Tech., Chicago (USA)	
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AS02-77ER04451	Utah Univ., Salt Lake City (USA). Dept. of Materials Science and Engineering	
	5:30741	COO—4451-3
AS02-77ER04463	Pennsylvania State Univ., University Park (USA). Dept. of Chemical Engineering	
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AS02-77ET11287	California Univ., Livermore (USA). Lawrence Livermore Lab.	
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AS02-77ET29102	Purdue Univ., Lafayette, IN (USA). School of Electrical Engineering	
	5:30610	PCTR—47-77
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AS02-77EV04327	Minnesota Univ., Minneapolis (USA)	
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AS02-78ET20604	Woods Hole Oceanographic Institution, MA (USA)	
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AS02-78ET37239	Kansas State Univ., Manhattan (USA). Dept. of Nuclear Engineering	
	5:31090	DOE/ET/37239—1
AS05-76ET12131	Ohio Dept. of Natural Resources, Columbus (USA). Div. of Geological Survey	
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AS05-76ET53045	College of William and Mary, Williamsburg, VA (USA). Dept. of Physics	
	5:31359	DOE/ET/53045—1
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AS05-77ET12038	University of Southern Mississippi, Hattiesburg (USA). Dept. of Polymer Science	
	5:30169	DOE/BETC/5603—10
AS09-76EV00890	Skidaway Inst. of Oceanography, Savannah, GA (USA)	
	5:31250	DOE/EV/00890—T1
AS09-77SR01025	Skidaway Inst. of Oceanography, Savannah, GA (USA)	
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AS19-79BC20006	Rice Univ., Houston, TX (USA)	
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AT01-76ET10696	Massachusetts Inst. of Tech., Cambridge (USA)	
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AT02-76CH93010	National Academy of Sciences - National Research Council, Washington, DC (USA). Div. of Medical Sciences	
	5:31239	DOE/CH/93010—1
AT03-76CS50115	SRI International, Menlo Park, CA (USA)	
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AT03-76ET35300	General Atomic Co., San Diego, CA (USA)	
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AT03-76ET51011	General Atomic Co., San Diego, CA (USA)	
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AT03-76SF70046	General Atomic Co., San Diego, CA (USA)	
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AT03-76SF71061	General Atomic Co., San Diego, CA (USA)	
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AT03-80SF10791	General Atomic Co., San Diego, CA (USA)	
	5:31060	GA-A—15828
EC-77-S-02-4206	Purdue Univ., Lafayette, IN (USA). Energy Sources and Systems Simulation Lab.	
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CONF-750607-		(American Nuclear Society meeting, New Orleans, LA, USA, 8-13 Jun 1975)
57	5:30266	*See* ARH-SA-203
CONF-770866-		(International cosmic ray conference, Plovdiv, Bulgaria, 13-26 Aug 1977)
P6	5:31257	*See* INIS-mf-5325
P8	5:31296	*See* INIS-mf-5313
CONF-7711136-		(Conference on energy efficiency in wood building construction, Chicago, IL, USA, 8-10 Nov 1977)
	5:30800	Madison, WI; Forest Products Research Society (1977).
CONF-780249-		(3. workshop on the use of solar energy for the cooling of buildings, San Francisco, CA, USA, 15-17 Feb 1978)
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	5:30821	*See* ISU-ERI-AMES-79103
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11	5:31087	*See* COO-3130-3
CONF-7905164-		(Engineering application of the finite element method conference, Oslo, Norway, May 1979)
1	5:31328	*See* LA-UR-80-1721
CONF-7909111-		(Symposium on the history of the ZGS, Argonne, IL, USA, 13-14 Sep 1979)
	5:31081	New York, NY; American Institute of Physics (1980).
CONF-791048-		(The Combustion Institute Western States Section meeting, Berkeley, CA, USA, 15-16 Oct 1979)
7	5:31073	*See* LBL-9900
CONF-791059-		(4. international symposium on polynuclear aromatic hydrocarbons, Columbus, OH, USA, 2-4 Oct 1979)
7	5:31183	NTIS, PC A02/MF A01
CONF-7910160-		(3. contractor information meeting on waste isolation safety assessment program task 4, Seattle, WA, USA, 14-17 Oct 1979)
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CONF-791187-	(Symposium on pulse combustion technology for heating applications, Argonne, IL, USA, 29-30 Nov 1979)	
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CONF-791196-	(Symposium on evaluation of existing concrete structures, Washington, DC, USA, 1 Nov 1979)	
1	5:30312	*See* RHO-SA-108
CONF-791204-	(2. Miami international conference on alternative energy sources, Miami Beach, FL, USA, 10-13 Dec 1979)	
39	5:31121	NTIS, PC A03/MF A01
CONF-800137-	(USDOE national workshop on ground water and energy, Albuquerque, NM, USA, 29-31 Jan 1980)	
1	5:31153	*See* LA-UR-80-1516
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CONF-800139-	(18. international winter meeting on nuclear physics, Bormio, Italy, 21-26 Jan 1980)	
1	5:31307	*See* LBL-10493
CONF-800205-	(American Institute of Metallurgical Engineers meeting, Las Vegas, NV, USA, Feb 1980)	
12	5:30899	*See* HEDL-SA-1883
13	5:30859	NTIS, PC A03/MF A01
CONF-800213-	(Band structure and nuclear dynamics conference, New Orleans, LA, USA, 28 Feb-1 Mar 1980)	
13	5:31305	NTIS, PC A02/MF A01
CONF-800233-	(6. international congress on endocrinology, Melbourne, Australia, 10-16 Feb 1980)	
1	5:31192	*See* UCRL-84292
CONF-800237-	(International symposium on coastal upwelling, Los Angeles, CA, USA, 4-8 Feb 1980)	
3	5:31152	*See* BNL-27885
CONF-800247-	(Conference on mathematical aspects of computerized tomography, Oberwolfach, F.R. Germany, 10-16 Feb 1980)	
1	5:30973	*See* BNL-28041
CONF-800303-	(179. national meeting of the American Chemical Society, Houston, TX, USA, 23-28 Mar 1980)	
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CONF-800304-	(5. international congress of the International Radiation Protection Association, Jerusalem, Israel, 8-14 Mar 1980)	
11	5:30322	NTIS, PC A02/MF A01
CONF-800318-	(Pittsburgh conference, Atlantic City, NJ, USA, 9-14 Mar 1980)	
3	5:30331	*See* HEDL-SA-2099-FP
CONF-800324-	(Seminar on electrochemical systems: batteries and fuel cells, Fortaleza-Ceara, Brazil, 2-6 Mar 1980)	
3	5:30789	NTIS, PC A02/MF A01
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CONF-800334-	(2. DOE environmental control symposium, Reston, VA, USA, 17-19 Mar 1980)	
17	5:31122	NTIS, PC A02/MF A01
CONF-800344-	(3. invitational well testing symposium, Oakland, CA, USA, 26-28 Mar 1980)	
2	5:30562	*See* SAND-80-0705C
CONF-800347-	(SIAM international conference on electric power problems: the mathematical challenge, Seattle, WA, USA, 18-20 Mar 1980)	
2	5:31435	*See* SAND-79-2476
CONF-800361-	(11. lunar and planetary science conference, Houston, TX, USA, Mar 1980)	
2	5:31260	NTIS, PC A03/MF A01
CONF-800365-	(International conference on the ecological impact of acid precipitation, Sandefjord, Norway, 11-14 Mar 1980)	
2	5:31228	*See* BNL-27597
CONF-800366-	(Specialists' meeting on LMFBR instrumentation and control, Tokyo, Japan, 31 Mar-4 Apr 1980)	
3	5:30675	NTIS, PC A03/MF A01
CONF-800375-	(Workshop on low and intermediate energy kaon-nucleon physics, Rome, Italy, 24-28 Mar 1980)	
1	5:31279	*See* BNL-27699

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CONF-800381-		(Annual general meeting and seminar on utilization of agricultural residues for paper and board, New Delhi, India, 29-30 Mar 1980)
	5:30812	NTIS (US Sales Only), PC A04/MF A01
CONF-800387-		(4. IEEE workshop on mass storage, Denver, CO, USA, 16-17 Mar 1980)
1	5:31440	*See* UCRL-84566
CONF-800391-		(Environmental degradation of high-temperature materials conference, Isle of Man, UK, 31 Mar-3 Apr 1980)
1	5:30066	NTIS, PC A02/MF A01
CONF-800393-		(Symposium on premature failure in monolithic refractory constructions: preventive and remedial treatment, Las Vegas, NV, USA, 2-7 Mar 1980)
1	5:30931	NTIS, PC A03/MF A01
CONF-800401-		(2. international conference of liquid metal technology for energy systems, Richland, WA, USA, 20-24 Apr 1980)
14	5:30683	*See* HEDL-SA-2133
15	5:30849	*See* HEDL-SA-1894-FP
23	5:30875	*See* HEDL-SA-1898-FP
CONF-800409-		(International conference on plasma physics, Nagoya, Japan, 7-11 Apr 1980)
6	5:31345	*See* PPPL-1639
CONF-800410-		(Electronic component conference, San Francisco, CA, USA, 28 Apr 1980)
4	5:31074	*See* BDX-613-2339
CONF-800419-		(5. symposium on automotive propulsion systems, Dearborn, MI, USA, 14-18 Apr 1980)
4	5:30836	NTIS, PC A02/MF A01
CONF-800427-		(Tritium technology in fission, fusion, and isotopic applications, Dayton, OH, USA, 29 Apr-1 May 1980)
5	5:31089	*See* LA-UR-80-1209
CONF-800433-		(4. international conference on nuclear methods in environment and energy research, Columbia, MO, USA, 14-17 Apr 1980)
7	5:30327	*See* AGNS-35900-CONF-61
CONF-800434-		(CSNI specialist meeting on nuclear aerosols in reactor safety, Gatlinburg, TN, USA, 15-17 Apr 1980)
5	5:30701	NTIS, PC A02/MF A01
CONF-800439-		(International conference on metallurgical coatings, San Diego, CA, USA, 21-25 Apr 1980)
2	5:30919	*See* GA-A-15805
CONF-800450-		(Annual adhesive conference, St Petersburg, FL, USA, 29-30 Apr 1980)
3	5:30932	*See* BDX-613-2432
CONF-800452-		(International conference on nuclear behavior at high angular momentum, Strassbourg, France, 22-24 Apr 1980)
1	5:31298	NTIS, PC A02/MF A01
CONF-800455-		(4. international conference on plasma surface interactions in controlled fusion devices, Garmisch, F.R. Germany, 21-25 Apr 1980)
17	5:30924	*See* SAND-80-0251C
CONF-800469-		(1. workshop on grand unification, Durham, NH, USA, 10-12 Apr 1980)
3	5:31282	*See* SLAC-PUB-2499
CONF-800480-		(ASCOT program planning meeting, Gettysburg, PA, USA, 15-18 Apr 1980)
4	5:31114	*See* UCRL-84534
5	5:31113	*See* LA-UR-80-2138
CONF-800482-		(Bio-energy world congress and exposition, Atlanta, GA, USA, 21-24 Apr 1980)
2	5:30403	NTIS, PC A02/MF A01
CONF-800490-		(Symposium on interaction between iron and proteins in oxygen and electron transport, Airlie House, VA, USA, 13-18 Apr 1980)
1	5:31171	*See* BNL-27860
CONF-800495-		(Evaluation of health risks associated with animal feeding and/or land application of municipal sludge conference, Tampa, FL, USA, 29 Apr-1 May 1980)
1	5:31203	*See* SAND-80-7088C
CONF-800498-		(Symposium on mutagenesis and carcinogenesis, Warsaw, Poland, 21-24 Apr 1980)
1	5:31231	NTIS, PC A03/MF A01
CONF-8004100-		(4. International Atomic Energy Agency technical committee meeting on large tokamak experiments, Tokyo, Japan, 14-18 Apr 1980)
1	5:31365	*See* GA-A-15869
CONF-800527-		(International BHP symposium, Columbus, OH, USA, 7-9 May 1980)
6	5:30310	*See* RHO-BWI-SA-50
7	5:30309	*See* RHO-BWI-SA-49
CONF-800538-		(ACS meeting-in-miniature, Tampa, FL, USA, 8-10 May 1980)
2	5:30742	*See* GEPP-OP-497
CONF-800541-		(Tar sands permeability enhancement workshop, Albuquerque, NM, USA, 8-9 May 1980)
3	5:30209	*See* SAND-80-1344C
CONF-800551-		(Symposium on neutron cross sections from 10 - 50 MeV, Upton, NY, USA, 12-14 May 1980)
12	5:31315	*See* LA-UR-80-1592
13	5:31314	*See* LA-UR-80-1591
16	5:31400	*See* HEDL-SA-2141-FP
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18	5:31401	*See* HEDL-SA-2148
CONF-800558-		(4. international conference on the theory and applications of graphs, Kalamazoo, MI, USA, 6-9 May 1980)
1	5:31438	*See* SAND-80-1140C
CONF-800564-		(12. annual symposium on system theory, Virginia Beach, VA, USA, 19-20 May 1980)
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3	5:30565	NTIS, PC A02/MF A01
CONF-800573-		(Conference on improving the scientific and technical information utilized in environmental impact statement, Rensselaerville, NY, USA, 19 May 1980)
1	5:30672	NTIS, PC A03/MF A01
CONF-800578-		(Conference on the utilization of small and medium size power reactors in Latin America, Montevideo, Uruguay, 12-15 May 1980)
1	5:30667	*See* GA-A-15868
CONF-800580-		(American Gas Association transmission conference, Salt Lake City, UT, USA, 5-7 May 1980)
2	5:30216	Chicago, IL; Institute of Gas Technology (1980).
CONF-800591-		(International conference on oxygen and oxy-radicals in chemistry and biology, Austin, TX, USA, 26-29 May 1980)
2	5:31173	*See* BNL-28040
CONF-800595-		(Cold Spring Harbor symposium No. 45: movable genetic elements, Cold Spring Harbor, NY, USA, 28 May-4 Jun 1980)
1	5:31191	*See* BNL-28042
CONF-8005101-		(International conference on water resources development, Taipei, Taiwan, 12-14 May 1980)
1	5:31243	NTIS, PC A02/MF A01
CONF-800601-		(13. Rochester international conference on environmental toxicity--measurement of risks, Rochester, NY, USA, 2-4 Jun 1980)
2	5:31213	NTIS, PC A02/MF A01
CONF-800604-		(American section of the International Solar Energy Society conference, Phoenix, AZ, USA, 2-6 Jun 1980)
30	5:30583	*See* SERI-TP-744-466R
31	5:30538	*See* SERI/TP-632-645
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39	5:30645	NTIS, PC A02/MF A01
58	5:30702	NTIS, PC A02/MF A01
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71	5:30682	*See* HEDL-SA-2032-FP
72	5:30671	*See* HEDL-SA-1987-FP
75	5:31088	*See* HEDL-SA-2059
79	5:30267	NTIS, PC A03/MF A01
80	5:30295	NTIS, PC A03/MF A01
CONF-800609-		(10. international symposium on effects of radiation on materials, Savannah, GA, USA, 3-5 Jun 1980)
4	5:30902	*See* HEDL-SA-2004-FP
5	5:30271	*See* DP-MS-80-27

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7	5:30898	*See* HEDL-SA-1512-FP
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12	5:30901	*See* HEDL-SA-2002-FP
13	5:30900	*See* HEDL-SA-2001-FP
CONF-800611-	(International symposium on the management of alpha-contaminated wastes, Vienna, Austria, 2-6 Jun 1980)	
9	5:30275	*See* HEDL-SA-1967
CONF-800629-	(Symposium on commercial uses of geothermal energy, Boise, ID, USA, 16-18 Jun 1980)	
3	5:30404	NTIS, PC A02/MF A01
CONF-800631-	(8. international cryogenic engineering conference, Genoa, Italy, 3-6 Jun 1980)	
8	5:31321	*See* LBL-10976
9	5:30617	*See* BNL-27854
CONF-800633-	(7. ocean energy conference, Washington, DC, USA, 2-5 Jun 1980)	
1	5:30467	NTIS, PC A02/MF A01
2	5:30468	NTIS, PC A02/MF A01
CONF-800640-	(14. pulse power modulator symposium, Orlando, FL, USA, 3-5 Jun 1980)	
5	5:31390	*See* SAND-80-0463C
CONF-800641-	(International conference on the metallurgical effects of high strain rate deformation and fabrication, Albuquerque, NM, USA, 22-26 Jun 1980)	
1	5:30879	*See* LA-UR-80-1543
CONF-800647-	(International conference on the physics of MOS insulators, Raleigh, NC, USA, 18-20 Jun 1980)	
3	5:30887	*See* LA-UR-80-1693
4	5:30912	NTIS, PC A02/MF A01
6	5:31318	*See* SAND-80-0395C
7	5:30908	NTIS, PC A02/MF A01
CONF-800655-	(21. annual meeting of the Institute of Nuclear Materials Management, Palm Beach, FL, USA, 30 Jun-2 Jul 1980)	
6	5:30264	*See* LA-UR-80-1794
8	5:30334	*See* LA-UR-80-1796
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25	5:30329	*See* HEDL-SA-2070-FP
27	5:30330	*See* HEDL-SA-2073-FP
29	5:30328	*See* BNL-28054
CONF-800656-	(Picosecond meeting, Falmouth, MA, USA, 18-20 Jun 1980)	
2	5:31172	*See* BNL-28027
3	5:31003	*See* LA-UR-80-1928
CONF-800658-	(Colloquium on nonparametric statistical inference, Budapest, Hungary, 22-28 Jun 1980)	
1	5:31427	*See* BNL-27929
CONF-800662-	(Bureau of Mines technology transfer seminar, Evansville, IN, USA, 3 Jun 1980)	
	5:30136	*See* BM-IC-8823
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CONF-800668-	(2. international symposium on ultrasonic materials characterization, Gaithersburg, MD, USA, 4-6 Jun 1980)	
1	5:31072	*See* HEDL-SA-1913
CONF-800670-	(7. European thermophysical properties conference, Antwerpen, Belgium, 30 Jun-4 Jul 1980)	
1	5:30885	NTIS, PC A02/MF A01
2	5:30981	*See* UCRL-84562
CONF-800673-	(13. national symposium on fracture mechanics, Philadelphia, PA, USA, 8-13 Jun 1980)	
1	5:30877	*See* HEDL-SA-2139
3	5:30876	*See* HEDL-SA-2102-FP

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1	5:30962	*See* BNL-27914
CONF-800680-	(Symposium on health effects investigations of oil shale development, Gatlinburg, TN, USA, 23-24 Jun 1980)	
2	5:31230	NTIS, PC A02/MF A01
3	5:30225	*See* UCRL-84557
CONF-800686-	(Society of Manufacturing Engineering Composites conference, Los Angeles, CA, USA, 10-12 Jun 1980)	
1	5:30536	*See* SAND-80-0702C
CONF-800687-	(Workshop on large-scale linear programming, Laxenburg, Austria, 2-6 Jun 1980)	
1	5:31428	*See* BNL-28070
CONF-800706-	(Western plant engineering conference, Anaheim, CA, USA, 15-17 Jul 1980)	
3	5:30525	*See* SERI/TP-733-665
CONF-800707-	(8. international conference on plasma physics and controlled nuclear fusion research, Brussels, Belgium, 1-10 Jul 1980)	
16	5:31383	*See* IAEA-CN-38/Q-1
17	5:31344	*See* IAEA-CN-38/BB-3-2
CONF-800712-	(15. AIAA thermophysics conference and 13. AIAA fluid and plasma dynamics conference, Snowmass, CO, USA, 14-16 Jul 1980)	
3	5:31025	*See* SAND-80-1648C
4	5:31019	*See* SAND-79-8831
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13	5:30743	*See* SAND-80-0269C
CONF-800716-	(6. underground coal conversion symposium, Afton, OK, USA, 13-17 Jul 1980)	
13	5:30104	*See* SAND-80-0847C
CONF-800719-	(International symposium of the Society of Photo-Optical Instrumentation Engineers, San Diego, CA, USA, 28 Jul-1 Aug 1980)	
8	5:31388	*See* LA-UR-80-1927
9	5:31392	*See* UCRL-84008
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10	5:30637	*See* GA-A-15756
11	5:30385	*See* K/CSD/INF-79/23
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4	5:31283	*See* COO-3533-166
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2	5:30860	*See* DOE/ER/03158-89
3	5:30861	*See* DOE/ER/03158-90
CONF-800736-	(Research conference and international summer school on statistical distributions in scientific work, Trieste, Italy, 23 Jul-1 Aug 1980)	
1	5:31214	NTIS, PC A02/MF A01
CONF-800742-	(2. international congress on toxicology, Brussels, Belgium, 6-11 Jul 1980)	
1	5:31226	NTIS, PC A02/MF A01
CONF-800743-	(International conference on nuclear waste transmutation, Austin, TX, USA, 22-24 Jul 1980)	
1	5:30247	NTIS, PC A03/MF A01
3	5:30280	*See* UCRL-84356
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5	5:30268	NTIS, PC A02/MF A01
8	5:31446	*See* BNL-NCS-28103
CONF-800744-	(Ion beam modification of materials conference, Albany, NY, USA, 14-18 Jul 1980)	
1	5:30915	*See* SAND-80-0729C
2	5:30866	*See* SAND-80-1109C
4	5:30865	*See* SAND-80-0829C
5	5:30916	*See* SAND-80-0823C
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1	5:30587	*See* SAND-80-1639C

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1	5:30177	*See* SAND-80-1679C
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1	5:30316	*See* SAND-80-1592C
CONF-800804-		(ASME century 2 emerging technology conference, San Francisco, CA, USA, 10-22 Aug 1980)
12	5:30624	*See* UCRL-82118
15	5:30651	*See* LA-UR-80-642
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1	5:30532	*See* COO-4878-13
9	5:30668	*See* GA-A-15875
26	5:30420	*See* DOE/ET/20279-98
30	5:30345	*See* BNL-28007
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CONF-800807-		(AICHE symposium on developments in air pollution sampling and analysis, Seattle, WA, USA, 10-13 Aug 1980)
1	5:31158	*See* BNL-27264
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4	5:31021	*See* SAND-80-8640
5	5:30980	*See* SAND-80-8637
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4	5:31022	*See* UCRL-84653
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4	5:30248	*See* DP-MS-80-36
5	5:30272	*See* DP-MS-80-35
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3	5:31290	*See* LA-UR-80-1643
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1	5:31002	*See* BNL-28029
2	5:30416	*See* BNL-28028
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1	5:30514	NTIS, PC A02/MF A01
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1	5:31287	*See* SLAC-PUB-2515
CONF-800831-		(Cryogenic processes and equipment conference, San Francisco, CA, USA, 19-21 Aug 1980)
1	5:31378	*See* UCRL-83590
CONF-800901-		(Symposium on intermediate range atmospheric transport processes and technology assessment, Gatlinburg, TN, USA, 29 Sep-2 Oct 1980)
2	5:30260	*See* AGNS-35900-CONF-63
3	5:30323	*See* DP-MS-80-3
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2	5:30979	*See* LBL-10384
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3	5:30269	NTIS, PC A02/MF A01
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3	5:30737	*See* SAND-79-2155C
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2	5:30278	*See* RFP-3079
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2	5:30556	*See* LA-UR-80-1489
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4	5:30575	*See* LA-UR-80-1487
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22	5:30576	*See* LBL-10985
23	5:30569	*See* LBL-10983
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3	5:30314	*See* SAND-80-0307C
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2	5:30850	*See* LA-UR-80-1068
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